

**A Preliminary Guide to the
Response of Major Species of
Competing Vegetation to
Silvicultural Treatments**

by

D. Coates and S. Haeussler

Skeena Forestry Consultants
RR 2, Moncton Road
Smithers, B.C. V0J 2N0

March 1986

BC 
Ministry of Forests

BC
76
C
L23:9
1986
C.3

Canadian Cataloguing in Publication Data

Coates, D. (David)

A preliminary guide to the response of major
species of competing vegetation to silvicultural
treatments

(Land management handbook, ISSN 0229-1622 ; no. 9)

ISBN 0-7718-8481-8

1. Forest management — British Columbia. 2. Forest
ecology — British Columbia. 3. Plant competition —
British Columbia. I. Haeussler, S. (Sybille) II.
British Columbia. Ministry of Forests. III. Title.
IV. Series.

SB764.C3C62 1985 634.9'658 C85-092176-7

© 1986 Province of British Columbia

Published by the
Information Services Branch
Ministry of Forests
Parliament Buildings
Victoria, B.C.
V8W 3E7

Copies of this and other Ministry of Forests titles are available from
Queen's Printer Publications, Parliament Buildings, Victoria, B.C.
V8V 4R6.

Mention of trade names or products does not constitute endorsement by the authors or the B.C. Ministry of Forests.

ACKNOWLEDGEMENTS

This report contains much information gathered in discussions with researchers and field practitioners throughout British Columbia and in the U.S. Pacific Northwest. Although these individuals cannot all be mentioned here, their information and comments are gratefully acknowledged.

Special thanks are due to E. Hamilton who co-ordinated this project for the Research Branch, B.C. Ministry of Forests. H. Benskin, J. Boaleng, T. Braumandl, S. Conard, B.M. Geisler, J. Pollack, and O. Steen reviewed the manuscript and provided many helpful suggestions. C. Haeussler and L. Rankin assisted in the literature search. G. Montgomery edited the manuscript.

Illustrations appearing in this publication are from several sources. P. Frank, formerly with the Research Branch, B.C. Ministry of Forests, prepared many of the drawings. Illustrations were also taken from the following B.C. Provincial Museum publications:

Brayshaw, T.C. 1978. Catkin bearing plants of British Columbia. B.C. Provincial Museum Occasional Paper Series 18.

Szczawinski, A.C. 1962. The heather family (Ericaceae) of British Columbia. B.C. Provincial Museum Handbook No. 19.

Taylor, T.M.C. 1973. The ferns and fern-allies of British Columbia. B.C. Provincial Museum Handbook No. 12.

Taylor, T.M.C. 1973. The rose family of British Columbia. B.C. Provincial Museum Handbook No. 30.

Permission was also granted by the University of Washington Press to reproduce illustrations from:

Hitchcock, C.L., A. Cronquist, M. Ownbey and J.W. Thompson. 1969. Vascular plants of the Pacific Northwest. Vols. 1-5. University of Washington Press, Seattle, Wash.

Records from the B.C. Provincial Museum herbarium were used to prepare the distribution maps. The base map for the figures was also prepared by the B.C. Provincial Museum.

Funding for this report was provided for through the Intensive Forest Management Subsidary Agreement (I.F.M.S.A.). Publication has been funded under the Forest Resource Development Agreement (F.R.D.A.).

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iv
1 INTRODUCTION	1
2 AUTECOLOGICAL SUMMARY OF SELECTED PLANT SPECIES	3
3 RESPONSE TO SILVICULTURAL TREATMENTS	13
3.1 Overstory Removal	14
3.2 Manual Treatments	14
3.3 Chemical Treatments	15
3.4 Mechanical Site Preparation	15
3.5 Prescribed Fire	15
3.6 Other Treatments	16
4 SPECIES SUMMARIES	17
<i>Acer glabrum</i> (Douglas maple)	19
<i>Acer macrophyllum</i> (bigleaf maple)	21
<i>Alnus incana</i> ssp. <i>tenuifolia</i> (mountain alder)	23
<i>Alnus rubra</i> (red alder)	25
<i>Alnus viridis</i> (green and Sitka alder)	27
<i>Athyrium filix-femina</i> (lady fern)	29
<i>Betula papyrifera</i> (paper birch)	31
<i>Calamagrostis canadensis</i> (bluejoint)	33
<i>Calamagrostis rubescens</i> (pinegrass)	35
<i>Cornus sericea</i> (red-osier dogwood)	37
<i>Corylus cornuta</i> (hazelnut)	39
<i>Epilobium angustifolium</i> (fireweed)	41
<i>Gaultheria shallon</i> (salal)	43
<i>Lonicera involucrata</i> (black twinberry)	45
<i>Menziesia ferruginea</i> (false azalea)	47
<i>Polystichum munitum</i> (sword fern)	49
<i>Populus balsamifera</i> ssp. <i>balsamifera</i> (balsam poplar)	51
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> (black cottonwood)	53
<i>Populus tremuloides</i> (trembling aspen)	55
<i>Pteridium aquilinum</i> (bracken)	59
<i>Rhododendron albiflorum</i> (white-flowered rhododendron)	61
<i>Ribes bracteosum</i> (stink currant)	63
<i>Rubus idaeus</i> (red raspberry)	65
<i>Rubus parviflorus</i> (thimbleberry)	67
<i>Rubus spectabilis</i> (salmonberry)	69
<i>Salix</i> spp. (willows)	71
<i>Sambucus</i> spp. (elderberries)	73
<i>Symphoricarpos albus</i> (snowberry)	75
<i>Vaccinium membranaceum</i> (black huckleberry)	77
<i>Vaccinium ovalifolium</i> (oval-leaved blueberry)	79
<i>Viburnum edule</i> (highbush-cranberry)	81
5 GLOSSARY	87

TABLES

	Page
1 Distribution and habitat of selected species.....	4
2 Description and competitive status of selected species.....	6
3 Reproductive characteristics of selected species.....	9
4 Summary of species response to silvicultural treatments.....	82
5 Effectiveness of registered herbicides.....	84

1 INTRODUCTION

The establishment and growth of crop trees is often retarded by competing vegetation. In a silvicultural context, competing vegetation can be defined as any trees, shrubs, forbs, or grasses that inhibit the survival and growth of crop trees.

The silviculturist must learn to control the establishment and growth of competing vegetation for the greatest long-term benefit to the growth of crop trees. In most instances, vegetative competition is only a serious problem while the crop trees are young, making complete eradication of a particular competitor from a site unnecessary. Some competitors may even benefit the growth of crop trees over the long term. Eradication of these species may be undesirable. On the other hand, certain hardwood trees can have a negative impact on crop tree growth for the entire length of the rotation.

Good vegetation management requires a basic understanding of the ecological characteristics of individual competitors and how they respond to silvicultural treatments. This report documents what is currently known about the response of major species of competing vegetation in British Columbia to various silvicultural treatments now in use. The information has been gathered from a variety of published and unpublished sources, and through conversations with researchers and practitioners in vegetation management and related fields.

The 31 species included in the guide have been selected because they are perceived to compete significantly with crop trees for available site resources. Some species, such as red alder, are serious competitors in their own right and are known to have a major impact on the growth of some conifers. Other species, like oval-leaved blueberry, are extremely abundant in certain areas of the province and are a component of important brush communities, but little is known about the effect that they, as individual species, have on crop tree growth.

This guide does not provide prescriptions for the management of competing vegetation; it merely summarizes important autecological characteristics of competing species and provides information about how it is thought the species respond to current silvicultural practices. Current knowledge of these subjects is limited, and reflects the fact that vegetation management research in British Columbia is just beginning. Nonetheless, it is hoped that the guide will provide some useful information to silviculturists who wish to know more about the species that compete with their crop trees.

The information contained in this report is not referenced. Most, but not all, of the statements can be traced to their source in the literature review entitled "Autecological Characteristics of Selected

Species that Compete with Conifers in British Columbia"¹, which was prepared as a companion publication to this guide. Had the information in this report been restricted to that from the literature, much valuable information from field practitioners and others could not have been included.

¹ S. Haussler and D. Coates. [1985]. Autecological characteristics of selected species that compete with conifers in British Columbia: a literature review. B.C. Min. For., Land Manage. Rep. No. 33.

2 AUTECOLOGICAL SUMMARY OF SELECTED PLANT SPECIES

The term autecology combines the prefix auto, meaning "self", with ecology and refers literally to the ecology of an individual organism. Plant autecology is the study of the adaptations and behaviour of individual plant species or populations in relation to their environment. Most foresters are already familiar with the subject of autecology as it relates to tree species, but they use the term silvics. The two terms are synonymous except that autecology does not limit itself to tree species.

Tables 1-3 summarize autecological information for each of the plant species included in this guide. Table 1 provides information about the distribution and habitat preferences of each species, while Tables 2 and 3 summarize the plants' physical attributes and their reproductive characteristics. The information is condensed from the companion literature review describing the autecology of these species. It is recommended that readers refer to the literature review for more detailed information about any of the plant species in this guide.

Table 1. Distribution and habitat of selected competing species.

Species	Distribution	Altitudinal range	Habitat conditions	Shade tolerance
<i>Acer glabrum</i> (Douglas maple)	Throughout B.C., except northeast	Low to medium elevations. Absent from subalpine	Dry to moist sites. Often on rocky soils	Moderate
<i>Acer macrophyllum</i> (bigleaf maple)	South Coast only	Low elevations only	Variable. Mostly moist, rich sites	Low to moderate
<i>Alnus incana</i> ssp. <i>arutifolia</i> (mountain alder)	Throughout B.C., east of Coast Mtns.	Valley bottoms to alpine	Moist to wet rich sites	Moderate (high)
<i>Alnus rubra</i> (red alder)	Entire length of Coast	Low to medium elevations below 800 m	Prefers disturbed and alluvial soils	Low
<i>Alnus viridis</i> (Silka or green alder)	Green: northeast only. Silka: elsewhere in B.C.	Valley bottoms to alpine	Cool, moist habitats. Invades disturbed soil	Moderate (high)
<i>Athyrium filix-femina</i> (lady fern)	Throughout B.C., except dry interior	Sea level to subalpine	Moist to wet, medium to rich sites	High (moderate)
<i>Betula papyrifera</i> (paper birch)	Throughout B.C., except outer Coast	Low to medium elevations	Variable, prefers well-drained soils	Low
<i>Calamagrostis canadensis</i> (bluejoint)	Throughout B.C., most abundant in north	Sea level to subalpine. Higher elev. in south	Upland and wetland sites. Disturbed soil and past	Moderate
<i>Calamagrostis rubescens</i> (pinegrass)	Central and southern interior	Valley bottoms to subalpine elevations	Dry to moist sites. Drought tolerant	Moderate (high)
<i>Cornus sericea</i> (red-osier dogwood)	Throughout B.C.	Low to medium elevations. Absent from subalpine	Moist to wet sites. Often on alluvial sites	Moderate
<i>Corylus cornuta</i> (hazelnut)	Discontinuous in major valleys throughout B.C.	Mostly low elevations, interior valley bottoms	Variable, best on alluvial sites	Moderate
<i>Epilobium angustifolium</i> (fireweed)	Throughout B.C.	Sea level to alpine meadows	Extremely variable, follows disturbance	Low
<i>Gaultheria shallon</i> (salal)	Entire length of Coast	Low elevations, to medium elev. in south	Variable, often on rocky or boggy sites	Moderate
<i>Lonicera involucrata</i> (black hawberry)	Throughout B.C., except far north	Sea level to 1500 m	Riparian, moist woods. Often in frost pockets	Moderate
<i>Menziesia ferruginea</i> (false azalea)	Coastal and moist mountainous areas	Sea level to alpine. Not in interior valleys	Mostly mesic, forested habitats	High
<i>Polystichum munitum</i> (sword fern)	Entire length of Coast	Low elevations, to medium elev. in south	Moist, medium to rich sites	High
<i>Populus balsamifera</i> ssp. <i>balsamifera</i> (balsam poplar)	Northeastern B.C., Rocky Mountains and east	Low to medium elevations	Alluvial or moist upland sites	Very low
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> (black cottonwood)	Throughout B.C., except northeast	Sea level to lower subalpine	Often on alluvial sites. Also moist uplands	Very low

Table 1. Distribution and habitat of selected competing species—Continued.

Species	Distribution	Altitudinal range	Habitat conditions	Shade tolerance
<i>Populus tremuloides</i> (trembling aspen)	Throughout B.C., except outer Coast	Valley bottoms to subalpine	Variable. Dry to moist sites	Low
<i>Pteridium aquilinum</i> (bracken)	Scattered, esp. Coast and southeastern interior	Mostly low elevations	Wide variety of disturbed habitats	Moderate
<i>Rhododendron</i> <i>adiflorum</i> (white-flowered rhododendron)	Mountainous areas throughout B.C.	Subalpine elevations. Dry to mesic sites	Forested and open slopes (high)	Moderate
<i>Ribes bracteatum</i> (stink currant)	Entire length of Coast. Rarely inland	Mostly low elevations	Riparian or alluvial habitats	Moderate to low
<i>Rubus idaeus</i> (red raspberry)	Throughout B.C., east of Coast Mtns.	Interior valley bottoms to subalpine	Disturbed, open sites moist, moderately rich	Low
<i>Rubus parviflorus</i> (thimbleberry)	Throughout B.C., except far north	Sea level to lower subalpine	Variable. Prefers moist, rich sites	Moderate
<i>Rubus spectabilis</i> (salmonberry)	Entire length of Coast	Sea level to alpine, abundant below 800 m	Moist slopes, streambanks and lowland forest	Moderate
<i>Salix</i> spp. (willows)	Throughout B.C.	Sea level to alpine	Extremely variable. Often riparian	Low to moderate
<i>Sambucus</i> spp. (elderberries)	Throughout B.C., uncommon in far north	Low to medium elevations	Usually on moist, rich habitats	Low
<i>Symphoricarpos albus</i> (snowberry)	Throughout B.C., except far north	Low to medium elevations	Extremely variable. Drought tolerant	Moderate
<i>Vaccinium</i> <i>membranaceum</i> (black huckleberry)	Throughout B.C., rare on Coast and in north	Mid-elevations to subalpine	Dry to moist coniferous forest and openings	Moderate (high)
<i>Vaccinium ovalifolium</i> (oast-leaved blueberry)	Coast and moist mountainous areas	Coast: sea level to alpine interior: higher elev.	Acidic coniferous forest. Dry to wet sites	High
<i>Viburnum edule</i> (highbush-cranberry)	Throughout B.C., esp. northern half	Sea level to lower subalpine	Moist medium to rich sites, often alluvial	Moderate

Table 2. Distribution and habitat of selected competing species.

Species	Growth habit	Growth	Competitive status	Benefits to conifers
<i>Acer glabrum</i> (Douglas maple)	Small tree or multistemmed shrub up to 10 m tall	Moderately rapid juvenile growth	Most significant on drier sites	Nutrient-rich litter. May provide shade on harsh, south aspects
<i>Acer macrophyllum</i> (bigleaf maple)	Tree or large multistemmed shrub, up to 25 m or more in ht.	Rapid juvenile growth. Stump sprouts may grow 2-4m in 1st year	Major competitor on rich coastal sites. Very broad crown	Nutrient-rich litter
<i>Alnus incana</i> ssp. <i>terrestris</i> (mountain alder)	Small tree or coarse shrub up to 12 m tall	Moderately rapid juvenile growth	Forms dense thickets on wet sites	Nitrogen fixation. Builds up site organic matter
<i>Alnus rubra</i> (red alder)	Tree or tall shrub up to 25 m tall	Rapid juvenile growth. Can be 10 tall by age 5	Major competitor throughout its range.	Nitrogen fixation. Builds up site organic matter
<i>Alnus viridis</i> (Silva or green alder)	Small tree or coarse shrub up to 9 m tall	Growth rates vary greatly depending on size and site. Takes 3-4 yr to reach 1 m	Moderate competitor. Only serious where abundant	Nitrogen fixation. Builds up site organic matter
<i>Athyrium filix-femina</i> (lady fern)	Perennial fern with large deciduous fronds up to 2 m tall	Fronds have determinate growth. Rapid frond development in spring — die back in autumn	Not a major competitor. Dense stands on moist, rich sites. Shade and mechanical damage to seedlings	Unknown
<i>Betula papyrifera</i> (paper birch)	Tree, often multistemmed up to 30 m tall	Moderate juvenile growth	Serious long-term competitor if densely established	Unknown. Nutrient-rich litter?
<i>Calamagrostis canadensis</i> (bluejoint)	Rhizomatous perennial grass to 120 cm tall	Forms dense mats. Rapid height growth during growing season, but dies back in fall	Serious competitor in boreal forest and on wet sites in other subzones	Can control surface soil erosion. May restrict establishment of larger species
<i>Calamagrostis rubescens</i> (pinegrass)	Rhizomatous perennial grass to 1 m tall	Forms dense roots mats. Relatively low-growing compared to other competing species	Major competitor on droughty sites in Interior Douglas-fir area	Can control surface soil erosion. Increases soil organic matter. May prevent overstocking of lodgepole pine
<i>Cornus sericea</i> (red-osier dogwood)	Deciduous shrub with prostrate rooting branches, up to 5 m tall	Rapid growth. Suckers or sprouts can grow 1 m in first growing season	Significant competitor on subhygic to hygic sites. Part of a major brush community	No information
<i>Corylus cornuta</i> (hazelnut)	Deciduous thicket-forming shrub up to 4 m tall	Sprouts exhibit rapid growth, but seedling growth and clonal expansion are slow	Can be an aggressive localized competitor	Nutrient-rich litter
<i>Epilobium angustifolium</i> (flewweed)	Tall rhizomatous perennial herb, up to 3 m tall	Rapid lateral expansion of rhizome-like root system. Aerial shoots grow rapidly but die back in autumn	Very abundant and aggressive invader. Dead stems often cause mechanical damage to young seedlings	Can reduce invasion by woody competitors

Table 2. Distribution and habitat of selected competing species—Continued.

Species	Growth habit	Growth	Competitive status	Benefits to conifers
<i>Gaultheria shallon</i> (salal)	Evergreen, rhizomatous shrub, up to 2.5 m tall	Slow growing. Forms very dense thickets	Serious competitor on mesic and drier coastal ecosystems	No information
<i>Lonicera involucrata</i> (black twinberry)	Deciduous shrub up to 3 m tall	Moderate to rapid juvenile growth. Clumps do not expand rapidly	Moderate competitor. Component of vigorous brush communities	No information
<i>Menziesia ferruginea</i> (false azalea)	Deciduous shrub up to 3 m tall	Relatively slow growing. Does not sucker	Little known. Part of Ericaceous shrub complex	No information
<i>Polystichum munitum</i> (sword fern)	Perennial fern with evergreen fronds and a woody rhizome, up to 1.8 m tall	Fronds have determinate growth and persist for several years	Not a major competitor. Abundant on moist, rich, coastal sites	No information
<i>Populus balsamifera</i> ssp. <i>balsamifera</i> (balsam poplar)	Deciduous tree with long straight trunk and open crown, up to 35 m tall	Rapid juvenile growth especially when of sucker origin	Can be a serious competitor because of rapid growth, and prolific sucker, sprout, and seed production	No information
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> (black cottonwood)	Large deciduous tree with long straight trunk and open crown, up to 40 m tall	Extremely rapid juvenile growth	Serious long-lived competitor on alluvial sites	No information
<i>Populus tremuloides</i> (trembling aspen)	Medium-sized deciduous tree up to 25 m tall	Rapid juvenile growth. Suckers can grow 2 m in the first growing season	Major competitor throughout the Interior. Produces prolific suckers	Nutrient-rich litter
<i>Pteridium aquilinum</i> (bracken)	Tall rhizomatous perennial fern, up to 2 m tall	Extensive underground growth. Fronds expand rapidly but die back in autumn	Dominates a wide variety of sites. Forms a dense canopy. May be allelopathic	None described
<i>Rhododendron adibiflorum</i> (white-flowered rhododendron)	Deciduous, slender-branched shrub, up to 2.5 m tall	Relatively slow-growing	Little known. Major component of an Ericaceous shrub complex	May provide shade on exposed, droughty sites
<i>Ribes bracteosum</i> (slink currant)	Erect to spreading deciduous shrub, up to 3 m tall	Relatively rapid growth	Important competitor on moist, rich sites on the mid- and north Coast	No information
<i>Rubus idaeus</i> (red raspberry)	Deciduous, rhizomatous shrub with biennial canes up to 2 m tall	Rapid above and below ground growth, but canes are short-lived	Aggressive invading plant. Can form a dense canopy 3–5 years after disturbance	Limits invasion of taller, longer-lived species
<i>Rubus parviflorus</i> (thimbleberry)	Deciduous, rhizomatous shrub with short-lived canes, up to 2 m tall	Rapid above and below ground growth, but canes are relatively short-lived	Major competitor throughout B.C. Forms a very dense canopy and can quickly smother seedlings	No information

Table 2. Distribution and habitat of selected competing species—Continued.

Species	Growth habit	Growth	Competitive status	Benefits to conifers
<i>Rubus spectabilis</i> (salmonberry)	Deciduous, rhizomatous erect or creeping shrub, up to 5 m tall	Rapid shoot and rhizome growth, but canes are relatively short-lived	Major competitor on moist, rich coastal areas. Forms dense thickets	Can inhibit invasion of hardwood trees
<i>Salix</i> spp. (willows)	Deciduous small trees and multistemmed shrubs. Variable in size	Rapid early growth, especially when of sprout origin	Moderate to serious competitors. Easily outgrow conifers	No information
<i>Sambucus</i> spp. (elderberries)	Deciduous coarse shrub or small tree with a broad, arching crown, up to 9 m tall	Rapid sprout growth. Seedling growth relatively slow	Rarely a primary competitor, but part of major brush complexes. Allelopathy possible	May provide shade on harsh, droughty sites
<i>Symphoricarpos albus</i> (snowberry)	Small to medium-sized, erect, deciduous shrub up to 2 m tall	Relatively slow growth, except on very favourable sites	Moderate competitor. Abundant on dry sites in southern Interior	May provide shade on harsh, droughty sites
<i>Vaccinium membranaceum</i> (black huckleberry)	Small to medium-sized deciduous, rhizomatous shrub up to 2 m tall	Slow height growth and lateral spread	Little known. Probably not a major competitor, but a major component of an Ericaceous shrub complex	No information
<i>Vaccinium ovalifolium</i> (oval-leaved blueberry)	Diffusely branched deciduous shrub up to 2 m tall	Slow-growing, usually no more than 30 cm per year	Little known. Minor competitor, but abundant component of Ericaceous shrub complex	No information
<i>Viburnum adule</i> (highbush-cranberry)	Straggling to erect, multistemmed, deciduous shrub up to 3.5 m tall	Little information. Probably relatively slow height growth and lateral spread	Not a major competitor except in the north, but part of major brush complexes	No information

Table 3. Reproductive characteristics of selected species.

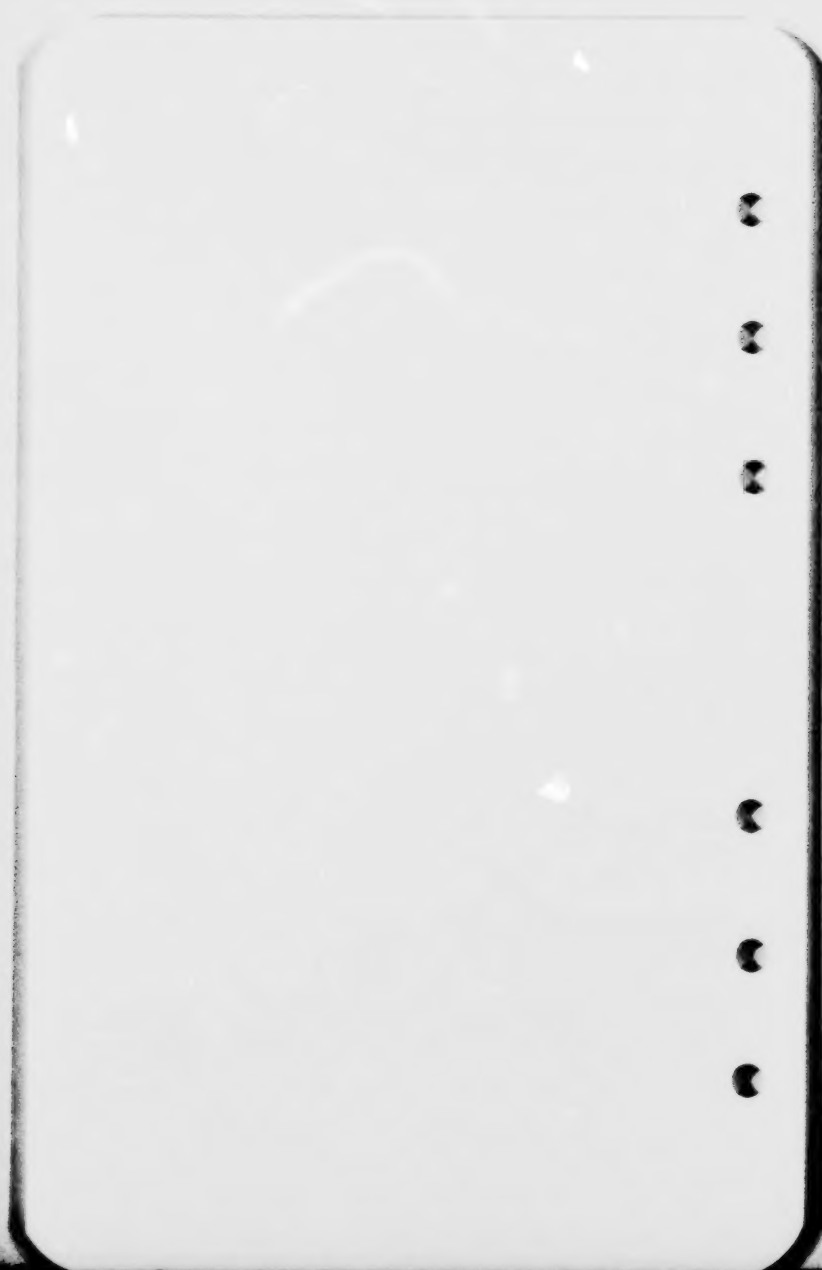
Species	Sexual reproduction			Vegetative reproduction	Comments
	Propagule description	Dispersal mechanism	Miscellaneous		
<i>Acer glabrum</i> (Douglas maple)	Winged seeds	Wind		Basal sprouts	
<i>Acer macrophyllum</i> (bigleaf maple)	Large winged seeds	Wind (rarely animals)	Seedlings survival depends on adequate moisture	Basal (stump) sprouts	Considered a seedling banker
<i>Alnus incana</i> ssp. <i>terrestris</i> (mountain alder)	Small, winged nutlets	Wind, Water	Low seed viability. Mineral soil seedbed preferred	Basal sprouts (Layering)	May be clone-forming
<i>Alnus rubra</i> (red alder)	Small, winged nutlets	Wind	Moist mineral soil seedbed preferred	Basal (stump) sprouts	Aggressively seeds-in to disturbed sites
<i>Alnus viridis</i> (Silka or green alder)	Small, winged nutlets	Wind, Water	Moist mineral soil seedbed preferred	Basal sprouts	Seeds-in to disturbed sites
<i>Athyrium filix-femina</i> (lady fern)	Spores	Wind, water and animals	Requires free water for sexual reproduction to succeed	Rhizomes	Prolific, widely disseminated spores. Forms small clones
<i>Betula papyrifera</i> (paper birch)	Small, winged nutlets	Wind	Dispersal mostly within 100 m of tree. Mixed mineral/organic seedbed preferred	Basal (stump) sprouts	Seeds-in most important form of regeneration
<i>Calamagrostis canadensis</i> (bluepoint)	Light seeds	Wind	Germinates on disturbed sites	Rhizomes	Invasives both rhizomatously and by seed
<i>Calamagrostis rubescens</i> (pinegrass)	Light seeds	Wind	Seed only produced in open areas	Rhizomes	Primarily a rhizomatous species, but seeds-in to disturbed areas
<i>Cornus sericea</i> (red-osier dogwood)	Globular fruit with a single seed	Birds, Mammals	Seed-banking species	Stolons or runners. Root suckers. Basal sprouts. Layering	Buried branch parts often root. Buried seed may germinate after a disturbance
<i>Corylus cornuta</i> (hazelnut)	Hard-shelled nuts	Small mammals (birds)	Infrequent crops. Low germination rate	Suckers. Basal sprouts	Forms extensive clones. Vegetative reproduction dominates
<i>Epilobium angustifolium</i> (liveseed)	Small, tufted seeds	Wind	Copious seed production	Rhizome-like root system	Aggressively seeds-in to disturbed sites, then spreads by means of rhizomes

Table 3. Reproductive characteristics of selected species—Continued.

Species	Sexual reproduction			Vegetative reproduction	Comments
	Propagule description	Dispersal mechanism	Miscellaneous		
<i>Gaultheria shallon</i> (salal)	Many-seeded fleshy capsules	Birds, Mammals	Best germination on decaying wood. Seedling survival is low	Root suckers. Basal sprouts. Layering	Once established, further expansion is almost entirely by vegetative means
<i>Lonicera involucrata</i> (black twinberry)	Paired berries	Birds, Mammals	Seed-banking species	Basal sprouts. Little information	Apparently not an aggressive invader but little known
<i>Menziesia ferruginea</i> (false azalea)	Small, naturally dehiscent seeds	Gravity, Wind	Little information	Basal sprouts	Apparently not an aggressive invader but little known
<i>Polystichum munitum</i> (sword fern)	Spores	Gravity, wind, water and animals	Free water required for successful sexual reproduction	Woody rhizome	Prolific, widely disseminated spores. May form clones
<i>Populus balsamifera</i> ssp. <i>balsamifera</i> (balsam poplar)	Fluffy seeds	Wind, Water	Prolific seed production. Germination occurs readily on exposed mineral soil	Root suckers. Basal (stump) sprouts. Buried branch parts often root	Both seedling-in and suckering are important means of reproduction
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> (black cottonwood)	Fluffy seeds	Wind, Water	Most seedbed essential for germination and seedling survival	Basal (stump) sprouts. Buried branch parts often root	Seedling-in is the dominant means of reproduction
<i>Populus tremuloides</i> (trembling aspen)	Fluffy seeds	Wind	Seedling establishment is rare	Root suckers. Basal (stump) sprouts (rare)	Rapidly colonizes areas through root suckering
<i>Pteridium aquilinum</i> (bracken)	Spores	Gravity, wind, water and animals	Most often germinates on sterile, disturbed soil	Rhizomes. Stem fragments readily regenerate	Forms large clones through rhizomatous growth
<i>Rhododendron albiflorum</i> (white-flowered rhododendron)	Small, naturally dehiscent, winged seeds	Wind	Little known but seedling establishment probably rare	Basal sprouts	Apparently not an aggressive invader but little known
<i>Ribes bracteatum</i> (stink currant)	Glandular berries	Birds, Mammals	Seed-banking species	Basal sprouts	Seedling establishment on disturbed soil probably most important means of reproduction
<i>Rubus idaeus</i> (red raspberry)	Aggregate, berry-like fruit	Birds, Mammals	Seed-banking species	Rhizomes. Basal sprouts	Rapidly establishes on disturbed sites by seed. Once established, further spread is by rhizomatous growth

Table 3. Reproductive characteristics of selected species—Continued.

Species	Propagule description	Sexual reproduction		Vegetative reproduction	Comments
		Dispersal mechanism	Miscellaneous		
<i>Rubus parviflorus</i> (rhubarb)	Aggregate, berry-like fruit	Birds, Mammals	Seed-banking species	Rhizomes, Basal sprouts	Rapidly establishes on disturbed sites by seed. Once established, further spread is by rhizomatous growth
<i>Rubus spectabilis</i> (salmonberry)	Aggregate, berry-like fruit	Birds, Mammals	Seed-banking species	Rhizomes, Basal sprouts, Layering	Rapidly establishes on disturbed sites by seed. Once established, further spread is by rhizomatous growth
<i>Salix</i> spp. (willows)	Fluffy seeds	Wind, Water	Seed of most species germinates in summer within a few days of dispersal	Basal sprouts	Sprout growth can be prolific, but seedling in is the dominant means of reproduction
<i>Sambucus</i> spp. (elderberries)	Berry-like fruit	Birds, Mammals	Seed-banking species. Germinates on mineral and organic seedbeds	Basal sprouts, (Rhizomes)	May form clones in some areas. Apparently seeds-in to disturbed sites
<i>Symphoricarpos albus</i> (snowberry)	Berry-like fruit	Birds, Mammals	Seed-banking species	Basal sprouts, Rhizomes	Establishes by seed on disturbed soils. Once established, spreads by rhizomes to form low thickets
<i>Vaccinium membranaceum</i> (black huckleberry)	Berries	Birds, Mammals	(Seed-banking species?)	Rhizomes, Basal sprouts	Once established, further spread is by rhizomatous growth
<i>Vaccinium ovalifolium</i> (oval-leaved blueberry)	Berries	Birds, Mammals	Seed-banking species. Seedlings germinate in small forest openings	Rhizomes, Basal sprouts	Apparently banks seedlings in the mature forest
<i>Viburnum aduncum</i> (highbush cranberry)	Berry-like fruit with a single seed	Birds, Mammals	Seed-banking species	Layering, Basal sprouts, (Rhizomes?)	Apparently does not expand rapidly after establishment, but little known



3 RESPONSE TO SILVICULTURAL TREATMENTS

The remainder of the guide summarizes known information about how the species of competing vegetation respond to current silvicultural practices. The behaviour of each species in response to silvicultural treatments is described separately in Section 4, and summary tables allowing the reader to compare the responses of different species to various treatments are presented at the end of the section.

Current silvicultural practices are grouped into the following categories: 1) overstory removal, 2) manual treatments, 3) chemical treatments, 4) mechanical site preparation, 5) prescribed burning, and 6) other treatments. Explanatory notes pertaining to each of these treatment types appear below.

There are several important factors that must be taken into account in interpreting the information:

- The response of a particular plant will depend on the phase of the plant's life cycle during which the treatment is employed. The age of a plant at the time of treatment can be very important. Juvenile, mature, and overmature plants may respond quite differently to the same treatment. Season of treatment is also significant. Plants often behave quite differently when treatments are applied during the dormant season, early in the growing season, or late in the growing season.
- Many competing plants reproduce vegetatively as sprouts or suckers, as well as from seed. The resulting offspring may differ radically in size, seasonal development, growth rates, and resistance to disturbance.
- Most species included in this guide occur over a wide geographic area and on a wide variety of habitats in British Columbia. These widely distributed plants may vary significantly in their genetic makeup. In addition, the response of a particular plant to a silvicultural treatment will also vary according to local environmental conditions, and to the plant's competitive ability on a particular habitat. It is not possible to document the full range of potential plant responses under the wide variety of conditions found in British Columbia.
- Individual plants are normally present as part of a vegetation complex, or plant community. The competitive relationships among associated plants may determine the response of an individual plant to a silvicultural treatment. It is beyond the scope of this guide to consider the behaviour of vegetation complexes.
- The focus of this guide is on the response of the competing plant species to a silvicultural treatment, not the response of the crop tree. When we describe a treatment as ineffective in reducing the frequency and cover of a plant species, this does not necessarily mean that the treatment will fail to successfully establish a crop tree. For example, a mechan-

ical site preparation treatment may increase the number of stems of a competing shrub. However, the improved growing conditions and the delay in the recovery of the shrub may be sufficient to allow the seedling to reach a free-growing state. Interactions between competitors and crop trees are too complex a topic to be dealt with in this guide.

3.1 Overstory Removal

Competing plant species are often present prior to logging as understory plants beneath the tree canopy. Harvesting usually involves release from overstory shade, which is favourable to most aggressive competitors. Some degree of physical disturbance to understory plants and to the forest floor also takes place. Certain shade-intolerant plants will be absent prior to harvesting. The removal of the tree canopy and associated soil disturbance may create favourable conditions for the germination of freshly deposited or stored seeds of these pioneer species.

Deciduous tree species present in the overstory at the time of harvesting are either cut together with the crop trees or left as residuals. Comments regarding the response of mature deciduous trees to cutting are included in this section.

For some of the plant species, the effect of conifer thinning is also discussed under this heading.

Table 4 (p. 82) includes a summary of the response of all of the plant species to overstory removal.

3.2 Manual Treatments

Manual treatments involve cutting or girdling the competing plant species. Girdling treatments are generally applied only to tree species. Most perennial species either sprout from dormant buds on the stem base or root crown following harvesting, or produce suckers from roots or rhizomes at some distance from the main stem. Several factors appear to influence the response of a species to cutting:

1. The age of the plant. Sprout or sucker vigour generally decreases with age.
2. Season of treatment. Most species sprout or sucker less vigorously if they are cut during the growing season, particularly early in the season when reserve carbohydrate levels are low.
3. Height and angle of the cut stump. Lower stumps usually produce fewer sprouts. Stump angle can influence mortality rates in red alder, but this factor has not been studied for most other species.
4. Repeated cuttings. In some species, sprout or sucker vigour is diminished significantly following two or more cuttings, but other species are relatively unaffected. Repeated cuttings eventually deplete the food reserves of susceptible plants.

Table 4 (p. 82) summarizes the response of the plant species to manual treatments.

3.3 Chemical Treatments

The response of a plant species to application of a herbicide can vary considerably depending on the season and method of application, the carrier, dosage, weather conditions, and other factors. Within a given species, susceptibility to a particular chemical application may even vary according to latitude and other environmental factors.

This multitude of variables makes it difficult to summarize the response of a species to chemical treatment. For this reason, terms such as "good control" or "variable results" have been used in the guide to generalize the information for each species or chemical. Where appropriate, factors such as season, application method, carrier, and dosage have been specified. The comments are not a prescription for herbicide application, but rather a guide to the expected response of the species to the treatment described.

The emphasis in this section is on chemicals currently registered for forestry use in British Columbia: glyphosate (Roundup), hexazinone (Velpar), asulam (Asulox), 2,4-D, and simazine (Princep or Aquazine). In this report these five chemicals will be referred to by the names most commonly used by practitioners (i.e., Roundup, Velpar, Asulam, 2,4-D, and Simazine). Two unregistered chemicals, triclopyr (Garlon) and picloram (Tordon), are also mentioned in a few cases.

Table 5 (p. 84) summarizes the response of the plant species to chemical treatments.

3.4 Mechanical Site Preparation

There is little information documenting the response of a plant species to specific mechanical site preparation treatments. Most of the published information concerns the ability of the plant to invade areas of disturbed mineral soil or to regenerate from root or stem fragments.

The response of a plant to mechanical site preparation treatments varies significantly according to the severity of the treatments. Most plant species that colonize sites primarily by vegetative means, can be eradicated by severe treatments that actually uproot and remove roots and rhizomes. Such intensive land clearing techniques are rarely employed as part of current silvicultural practice.

Table 4 (p. 82) summarizes the response of the plant species to mechanical treatments.

3.5 Prescribed Fire

Plants differ greatly in their ability to withstand or recover from fire. Many of the major competing species are well adapted, or even favoured by fire. Other species can be successfully controlled through a single prescribed burn.

The response of a plant species to fire depends on certain characteristics of the plant: the resistance of its above-ground parts to fire damage, its ability to reproduce vegetatively from underground rhizomes or roots, its ability to reproduce from seed stored in

surface soil horizons, and its efficiency in dispersing fresh seed onto newly burned seedbeds.

The intensity and duration of a fire has a significant impact on the plant's ability to respond through the mechanisms described above. Burns carried out when humus and surface soil layers are dry, or over coarse-textured soils, may allow heat to penetrate deeply into the soil, destroying buried seed and killing underground perennating organs. A light fire that does not remove humus layers, but simply warms the mineral soil, may stimulate the germination of buried seed, or stimulate sprouting and suckering from dormant buds in undamaged portions of the plant.

Some fire-adapted species are favoured by fires of severe intensity and can withstand frequent, repeated fire, but the recovery of most species is inversely related to the intensity of the fire.

Table 4 (p. 82) summarizes the response of all the plant species to prescribed fire.

3.6 Other Treatments

There are many other potential silvicultural treatments in addition to those outlined above, but few have been documented with respect to their effects on specific plant species. Under this heading in Section 4 the effects of fertilization, grazing, and grass seeding on a limited number of plant species are discussed.

Combination treatments of manual, chemical, mechanical, or burning practices are also discussed, though information is limited. Because they may take advantage of the plants' vulnerability during a recovery phase, combination treatments can be some of the most effective treatments for controlling undesirable vegetation.

I

I

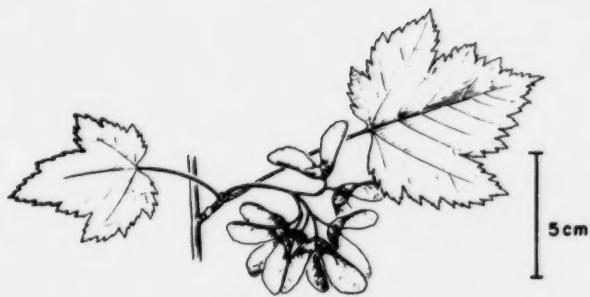
I

4 SPECIES SUMMARIES

I

I

I



Acer glabrum (Douglas maple).



Distribution of *A. glabrum* in British Columbia.

Acer glabrum

DOUGLAS MAPLE

Overstory Removal

- Abundance either remains static or increases slightly following logging operations; numbers may occasionally increase rapidly.
- The crown will normally take on a denser, more rounded form following canopy removal.

Manual Treatments

- Rapid sprouting will probably follow cutting, producing an increase in the total number of stems present.
- No information is available on the best time to cut this species to minimize the number of sprouts produced.
- No information is available on the effectiveness of manual treatments in reducing the cover of Douglas maple.

Chemical Treatments

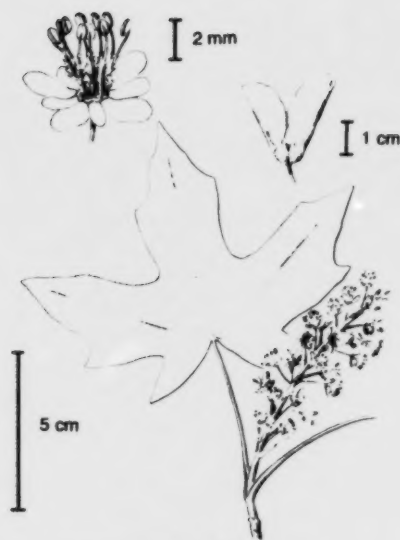
- Little information available.
- Foliar sprays of 2,4-D cause defoliation or top-kill; sprouting will probably follow.
- Roundup applied in the fall at 1.7 kg a.i./ha has provided good control in Oregon.

Mechanical Site Preparation

- No direct information available.
- Damaged stems often sprout back.
- This species may seed into areas of disturbed soil.

Prescribed Burning

- If the fire is not severe, the plant will sprout rapidly, producing an increase in the total number of stems present.
- Percent cover can increase dramatically over preburn levels within 5 years of burning.
- After fires of moderate to severe intensity, survival can be quite low.
- Expect variable results from burning.



Acer macrophyllum (bigleaf maple).



Distribution of *A. macrophyllum* in British Columbia.

Acer macrophyllum

BIGLEAF MAPLE

Overstory Removal

- The number of individual clumps generally does not increase following logging operations.
- Those plants already established on the site may increase in size and vigour.
- Seedling establishment is rare and is generally restricted to moist, rich sites similar to those where maple is normally found in the mature forest.
- Trees damaged during logging will sprout vigorously.

Manual Treatments

- Bigleaf maple will sprout rapidly after cutting and can grow 2-4 m in height in the 1st year.
- Cutting in late summer should produce the least sprouts for each original stem.
- Manual treatments alone are not considered to be a viable treatment option for reducing the cover of bigleaf maple.

Chemical Treatments

- To control bigleaf maple the chemical must kill the root system, otherwise vigorous sprouting will occur.
- The most effective control is achieved with injections (hack-and-squirt) or stump treatments. Roundup injected in the fall has provided effective control. Garlon provides excellent control.
- Injections or stump treatments carried out either prior to logging or during logging operations will minimize the number of stems requiring treatment.
- Stem treatments are the most effective when performed during periods of slow growth or in the dormant season.
- Basal sprays with Garlon have been very effective.
- Foliar sprays with Roundup have produced variable results. Fall applications may provide the best results.

Mechanical Site Preparation

- Damaged stems rapidly produce sprouts.
- Bigleaf maple does not usually seed-in significantly to areas of exposed mineral soil.
- Uprooting stumps offers good control.

Prescribed Burning

- Top-kill usually occurs and is followed by vigorous sprouting from the bases of damaged stems.
- Severe burns result in total kill of some plants.

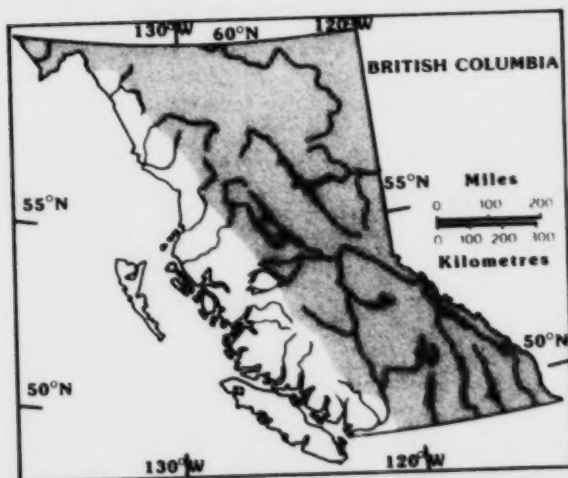
10 mm



3 cm



Alnus incana ssp. *tenuifolia* (mountain alder).



Distribution of *A. incana* ssp. *tenuifolia* in British Columbia.

Alnus incana ssp. *tenuifolia*

MOUNTAIN ALDER

Overstory Removal

- On very wet sites mountain alder will often increase significantly following overstory removal.
- Individual trees become larger and develop a fuller crown.

Manual Treatments

- Sprouts are produced from cut stem bases.
- There are no studies to show the effects of tree age, cutting height or angle, season of cut, or the effect of multiple cutting on the mortality and sprouting vigour of mountain alder; in a closely related eastern alder, cutting in July or August produced the fewest and least vigorous sprouts. Cutting at 4-5 year intervals did not reduce sprout vigour.

Chemical Treatments

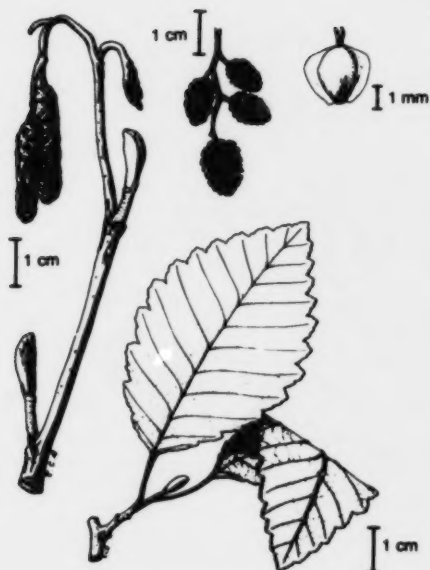
- Very little information available.
- Both Roundup and 2,4-D should successfully control mountain alder. Roundup is probably more effective.
- Velpar has little effect on mountain alder.

Mechanical Site Preparation

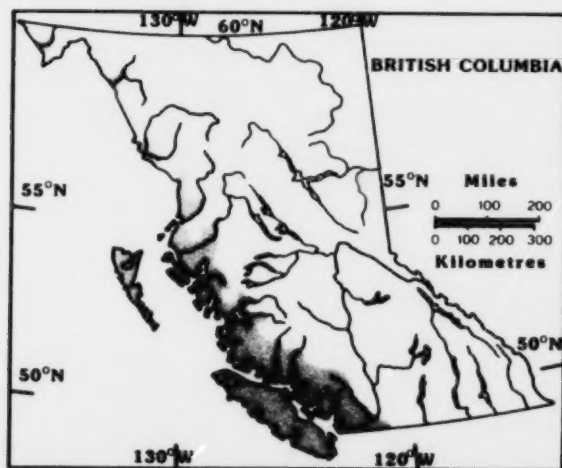
- Soil disturbance can create a suitable seedbed for germination and survival of mountain alder seedlings.
- Treatments that uproot the species will probably reduce its frequency.
- There are no studies to verify the above observations.

Prescribed Burning

- Mountain alder generally grows on wet sites that are difficult to burn.
- Fires of moderate to severe intensity are needed to set back the growth of this species. Such fires will rarely be possible on sites where mountain alder is abundant.



Alnus rubra (red alder).



Distribution of *A. rubra* in British Columbia.

Alnus rubra

RED ALDER

Overstory Removal

- Red alder will rapidly seed-in to disturbed, open areas following logging.
- Red alder can grow up to 1 m in height in its first season from seed.
- Between the ages of 2 and 5 years, red alder seedlings can reach growth rates of 3 m per year.

Manual Treatments

- Red alder will normally produce two to five sprouts per cut stem.
- Studies in Washington State have shown that:
 1. Sprouting vigour is greatest on trees aged 1 to 3 years
 2. To minimize sprouting, trees should be at least 10 years old. Trees over 15 years rarely had living sprouts 2 years after cutting.
 3. Trees cut during the growing season have a significantly higher mortality rate than those cut in the dormant season. Highest mortality was in trees cut in July and August. Lowest mortality was in trees cut in January.
 4. The lower the stump is cut, the higher the mortality rate. Mortality was 100% after two growing seasons when 2-year-old alders were cut in July leaving a stump less than 10 cm high.
 5. Mortality is higher on stumps with a level cut than on stumps with an angled cut.
 6. Repeated cuttings will significantly reduce the vigour of sprouting.
- Girdling results in satisfactory top-kill and minimizes sprouting. Double-frilled girdles are recommended over single girdles.

Chemical Treatments

- Both 2,4-D and Roundup applied as foliar sprays have successfully controlled red alder with minimal sprouting. Rates of 1-3 kg a.i./ha are sufficient for either chemical.
- Hack-and-squirt treatment with either 2,4-D or Roundup result in high rates of mortality.

Mechanical Site Preparation

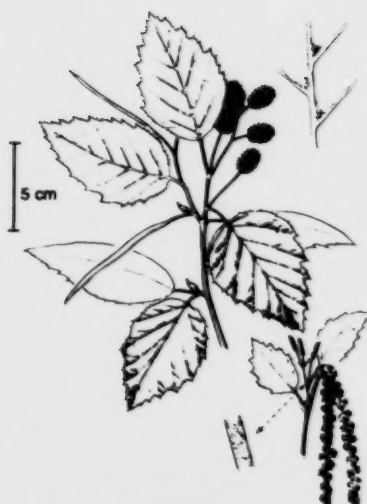
- Red alder will rapidly seed-in to areas of exposed mineral soil.
- Scarified sites usually have more alder than burned or untreated sites.
- Areas that are cleared by blade scarification often have 100% cover of alder after a few years.
- Red alder frequently invades coastal logging roads and skid trails, making them impassable.
- Mechanical treatments alone are not recommended for reducing red alder frequency or cover.

Prescribed Burning

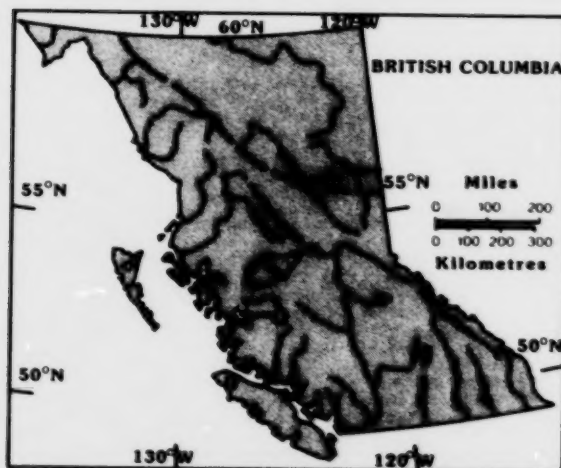
- Burns that do not expose large areas of mineral soil suitable for germination of red alder seed should reduce the amount of alder compared to unburned areas.
- Burned alder stumps usually sprout less than unburned stumps, but results depend on the severity of the fire.

Other Treatments

- Seeding large areas of exposed mineral soil with grass mixtures may reduce invasion of red alder. Further study is required to refine this treatment and confirm results.



Alnus viridis ssp. *sinuata* (Sitka alder).



Distribution of *A. viridis* in British Columbia. Subspecies *fruticosa* (green alder) is dominant north and east of the dashed line, while ssp. *sinuata* (Sitka alder) dominates to the south and west. There is a broad area of introgression between the two subspecies.

Alnus viridis ssp. *sinuata*
Alnus viridis ssp. *fruticosa*

SITKA ALDER
GREEN ALDER

Overstory Removal

- Neither Sitka nor green alder is expected to change much in frequency or cover following harvesting.
- Individual plants may improve in vigour and crowns will tend to fill out following release from an overstory.

Manual Treatments

- Cutting treatments are apparently quite successful in setting back Sitka alder, although no formal studies have been carried out.
- There are no studies documenting the effects of tree age, cutting height and angle, season of cut, or multiple cuttings on the mortality rate and sprouting vigour of Sitka or green alder.

Chemical Treatments

- Both Roundup and 2,4-D have been successful in controlling these alders.
- Velpar will have little effect on green or Sitka alder.

Mechanical Site Preparation

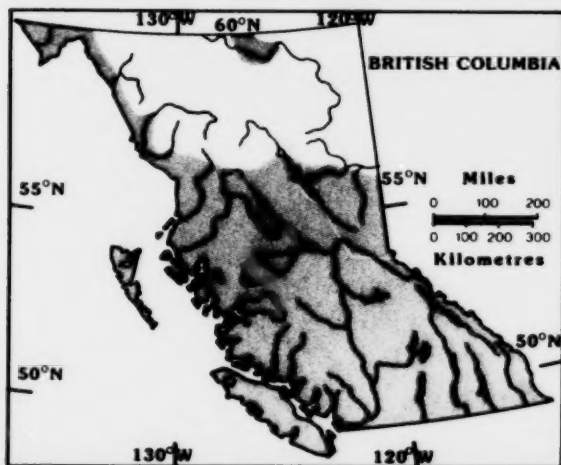
- Soil disturbance is likely to provide more suitable seedbeds for germination and survival of Sitka and green alder seedlings than undisturbed humus.
- Neither species seeds-in as aggressively as red alder.
- Treatments that uproot the species will probably reduce their frequency.
- There are no studies to verify the above observations.

Prescribed Burning

- Burning to control these species has produced variable results.
- Burns of moderate to severe intensity have successfully controlled Sitka alder for 5-7 years in some moist subzones of the Sub-Boreal Spruce and Engelmann Spruce-Sub-alpine Fir zones.



Athyrium filix-femina (lady fern).



Distribution of *A. filix-femina* in British Columbia.

Athyrium filix-femina

LADY FERN

Overstory Removal

- The moisture conditions of a site appear to be very important in determining the reaction of lady fern to canopy removal.
- On moist to wet (subhygric +) sites and in areas of high summer precipitation (e.g., SBSI subzone), lady fern remains vigorous and tends to increase slightly in abundance and cover following canopy removal.
- On sites prone to summer moisture stress following logging, lady fern will tend to lose vigour, and abundance and cover will decrease or remain static.

Manual Treatments

- No direct information.
- Underground rhizomes will allow the fern to regenerate early in the growing season.

Chemical Treatments

- Very little information available.
- Foliar application of Roundup in July or August at 2.25 kg a.i./ha caused 80-95% reductions in cover after the first growing season in studies near Prince George, B.C.

Mechanical Site Preparation

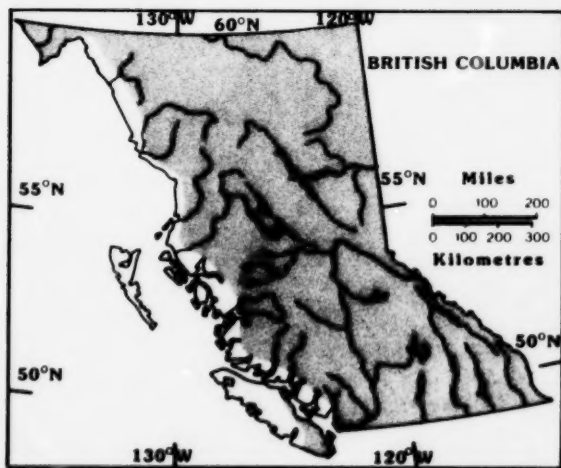
- No information available.

Prescribed Burning

- Burning either completely kills lady fern or causes a significant reduction in cover. Control is more pronounced on drier sites and on sites with coarser textured soils.
- Many sites with abundant lady fern are too wet for effective burns.



Betula papyrifera (paper birch).



Distribution of *B. papyrifera* in British Columbia.

Betula papyrifera

PAPER BIRCH

Overstory Removal

- Sprouting will often occur at the base of trees left standing following harvesting of conifers in mixed stands.
- Sprouting vigour of mature trees cut during harvesting is variable; sprout mortality is often high.
- Rapid seeding-in can occur in areas of disturbed mineral soil.

Manual Treatments

- Paper birch will sprout from either the root collar or the stump following cutting. It is not uncommon for six or seven sprouts to appear for every cut stem.
- Sprouting is believed to be more vigorous if trees are cut during the dormant season.
- There is scant information available documenting the effect of cutting season, height of cut, and multiple cuttings on the sprouting capacity of paper birch.
- Girdled paper birch will produce sprouts. Sprout number and vigour are variable. Girdled trees often produce fewer sprouts than cut trees.
- Double-frilled girdles or notched girdles are needed to ensure a high rate of mortality.

Chemical Treatments

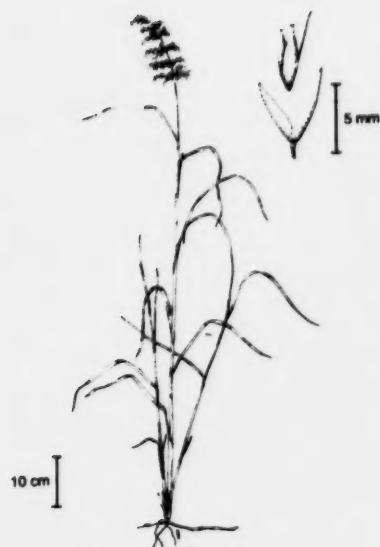
- 2,4-D ester, applied as an early foliar spray, and Roundup, as a late foliar spray, have provided good control of paper birch at rates of 2-3 kg a.i./ha. Garlon foliar sprays have also successfully controlled paper birch.
- Hack-and-squirt treatments with Roundup or 2,4-D provide good control. Birch bark frequently splits making this treatment more difficult.
- Variable results have occurred with Velpar.

Mechanical Site Preparation

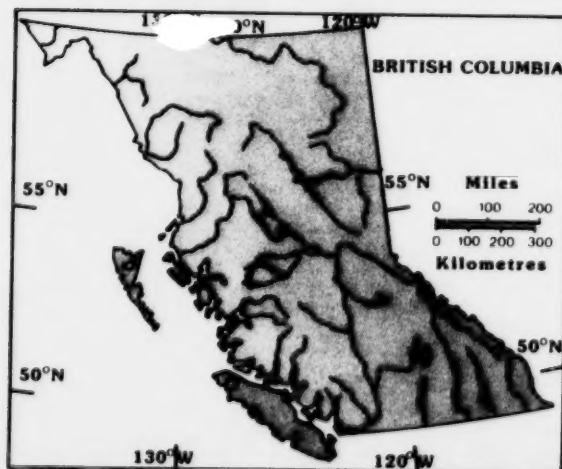
- Mechanical treatments that incorporate mineral soil and organic layers, as well as exposing areas of bare mineral soil, will provide excellent conditions for the germination and survival of paper birch seedlings.

Prescribed Burning

- Seedlings are generally more frequent on burned than on unburned areas. Burning probably prepares a good seed-bed for natural regeneration.
- Burned stumps sprout less than unburned ones, but there are no experimental data to verify this observation.
- Burns of moderate intensity will kill standing paper birch trees; the bark is thin and highly flammable.



Calamagrostis canadensis (bluejoint).



Distribution of *C. canadensis* in British Columbia.

Calamagrostis canadensis

BLUEJOINT

known in some areas as *C. scribneri* (Scribner's reed grass)

Overstory Removal

- On sites where bluejoint is already present prior to harvesting it will usually increase rapidly following canopy removal. The fastest increases are on areas of soil disturbance and compaction.
- Bluejoint is an aggressive colonizer in the boreal forest.

Manual Treatments

- Not applicable.

Chemical Treatments

- Roundup as a foliar spray at rates of 2.2-4.5 kg a.i./ha has provided good to excellent control for up to two growing seasons.
- Roundup may be more effective when applied in the late summer rather than the early summer.
- Velpar applied as a liquid spray at rates of 1.1-4.3 kg a.i./ha has provided excellent control of bluejoint.
- Simazine may provide good control.

Mechanical Site Preparation

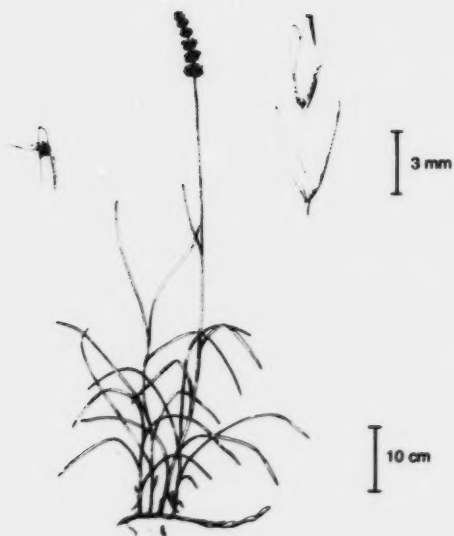
- Manually cleared scalps of approximately 30 X 30 cm had approximately 50% re-invasion by grass after 1 year on a site near Edson, Alberta.
- Heavy cultivation provides substantial control of established plants. The disturbed areas are then subject to seed-in by adjacent untreated plants.

Prescribed Burning

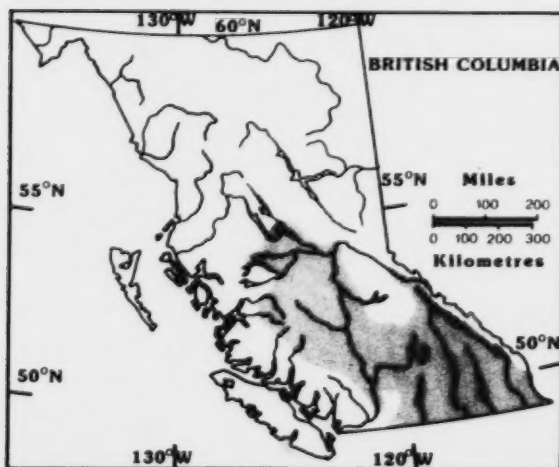
- Cover increases more rapidly on burned than on unburned areas.
- Fire stimulates rhizomatous sprouting and may create favourable seedbeds.
- Burning intensity does not appear to affect the rate at which bluejoint spreads on a site.

Other Treatments

- Bluejoint is generally considered to be intolerant to heavy grazing, but it is not a preferred species for cattle.



Calamagrostis rubescens (pinegrass).



Distribution of *C. rubescens* in British Columbia.

Calamagrostis rubescens

PINEGRASS

Overstory Removal

- Increases in abundance, vigour, and seed production following harvesting or thinning.

Manual Treatments

- Not applicable.

Chemical Treatments

- Velpar has provided good control at 2.2 kg a.i./ha in Washington and Oregon.
- Simazine has proven to be an effective chemical for control of pinegrass in trials conducted in the Kamloops Forest Region.

Mechanical Site Preparation

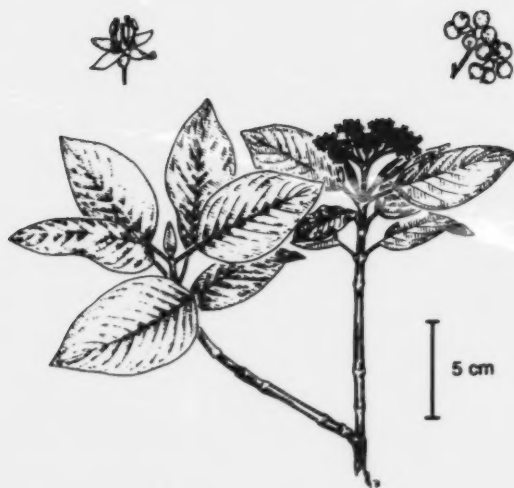
- Light to medium soil disturbance favours pinegrass while heavy disturbance may retard its growth.
- Anchor chain drag scarification can significantly increase its abundance and cover.
- Disc trenching or patch scarification can be used to reduce initial pinegrass competition for the purposes of plantation establishment; control will be short-lived.

Prescribed Burning

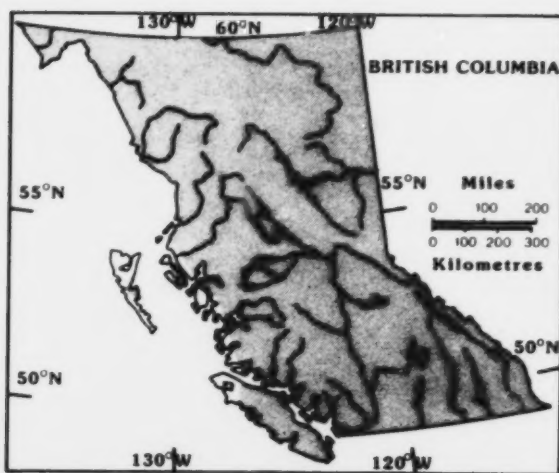
- Cover increases more rapidly on burned areas than on unburned areas.
- Pinegrass can increase rapidly by rhizomatous sprouting during the first growing season and by sprouting and seeding-in during subsequent growing seasons.
- Repeated fires promote the greatest increase in cover.

Other Treatments

- Pinegrass is susceptible to heavy grazing, but is only palatable early in the growing season.
- Fertilization with nitrogen can dramatically increase pinegrass cover and vigour.



Cornus sericea (red-osier dogwood).



Distribution of *C. sericea* in British Columbia.

Cornus sericea

RED-OSIER DOGWOOD

Overstory Removal

- Neither increases nor decreases dramatically following harvesting.
- Individual plants will usually become bushier.
- Cover increases slowly over time, especially on productive sites.

Manual Treatments

- There is very little information available regarding manual control of this species. Most manual treatments involve attempts to stimulate production of wildlife browse.
- Both sprouting and suckering will occur following cutting.
- Cutting early in the growing season can produce more sprouts than treatments undertaken during the dormant season. In an Oregon study, 14 sprouts were produced per original stem after cutting in spring, compared to eight sprouts for dormant cutting.
- The plant is unable to tolerate repeated, heavy browsing.

Chemical Treatments

- Red-osier dogwood is quite resistant to the herbicides registered for forestry use in British Columbia.
- In Oregon, 2,4-D was more effective when applied early in the growing season than when applied as the plant approached dormancy. Nearly all plants survived, but those sprayed earlier in the year were more chlorotic and deformed.

Mechanical Site Preparation

- Damaged plants may sprout or sucker.
- Broken stem parts that are incorporated into the mineral soil may root and subsequently produce aerial shoots.
- Some seeding-in may occur in areas of exposed mineral soil.
- Any change in cover following mechanical site preparation is unlikely to be dramatic unless plants are physically uprooted from the site.

Prescribed Burning

- Red-osier dogwood is a seed-banking species. Regeneration from seed is favoured most by fires of low severity and short duration that remove little of the surface organic matter. Prolific germination of stored seed is unlikely to occur.
- Fires of low intensity will stimulate sprouting and rejuvenate the shrub, but will not necessarily result in a rapid increase in abundance or cover.
- Severe fires that destroy the underground parts can dramatically set back this species and recovery will be slow.



Corylus cornuta (beaked hazelnut).



Distribution of *C. cornuta* in British Columbia.

Corylus cornuta

HAZELNUT

Overstory Removal

- Individual plants or clumps usually become more vigorous.
- Expect a gradual increase in abundance and cover through sprouting and suckering.
- Hazelnut is very slow to invade areas where it is not present prior to logging.

Manual Treatments

- Hazelnut sprouts prolifically following cutting and generally produces two to four sprouts per cut stem. Its ability to sprout is not significantly affected by repeated cuttings. Sprouts can grow 1-1.5 m in the 1st year.
- Suckering may also occur following cutting.
- One study indicated that less sprouting occurred when cutting took place late in the growing season rather than during the early foliar or dormant stages.
- Manual control is not considered an effective means of reducing hazelnut cover.

Chemical Treatments

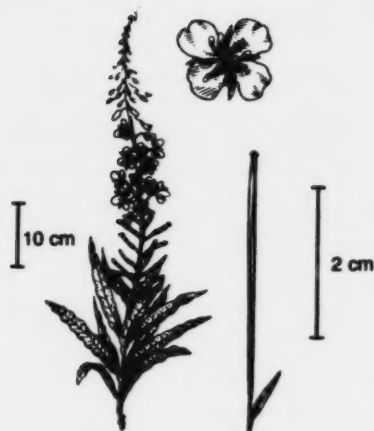
- 2,4-D produces heavy top-kill in hazelnut, but resprouting can be vigorous.
- Roundup has provided effective control of hazelnut. In Ontario a late August foliar spray at 2.24 kg a.i./ha was highly effective in killing hazelnut. Foliar treatments of Roundup during the spring, late summer, and fall have caused severe to very severe injury to hazelnut in Washington and Oregon.
- If sprouting occurs following chemical treatment it often does not take place until the second growing season.
- Double treatments (in which a second spray is applied to sprouts 2 years after the original application) can result in total control.

Mechanical Site Preparation

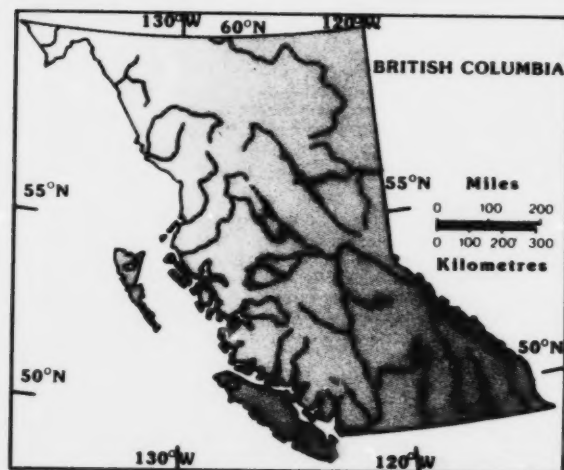
- Mechanical treatments must aim to destroy underground organs (to reduce the potential for suckering and sprouting).
- Both disc trenching and deep scarification with a brush blade have been successful in reducing the abundance and cover of hazelnut.

Prescribed Burning

- Aerial stems are killed regardless of fire intensity.
- Burning is followed by vigorous sprouting and suckering. Within a few years most stands will replace themselves with an increase in stem density over preburn levels.
- Underground stems and roots lie close to the soil surface and are susceptible to severe burns, but eradication of the plant will only occur if summer burning is repeated many times.



Epilobium angustifolium (fireweed).



Distribution of *E. angustifolium* in British Columbia.

Epilobium angustifolium

FIREWEED

Overstory Removal

- Airborne seeds allow fireweed to rapidly invade freshly logged areas.
- Once established it can become the dominant species on the site within 1 or 2 years.
- Rapid expansion is possible because it simultaneously forms large clones through spread of its fleshy root system, and produces large quantities of seed.

Manual Treatments

- Because the entire aerial shoot dies at the end of each growing season, manual treatments are only effective in reducing competition and mechanical damage during the remainder of the growing season during which cutting took place.
- Cutting stimulates sprouting from stem bases and the production of new root suckers.

Chemical Treatments

- Chemicals must act on the extensive root system to be effective.
- Roundup generally provides good control of fireweed; 2 years after Roundup was applied with a Micron Herbi at 500 g a.i./ha in late July near Blue River, B.C., the majority of fireweed was still dwarfed and deformed. Foliar sprays at 2.25 kg a.i./ha have caused significant reductions in cover.
- Results with Velpar have been variable.
- Fireweed is susceptible to Simazine.

Mechanical Site Preparation

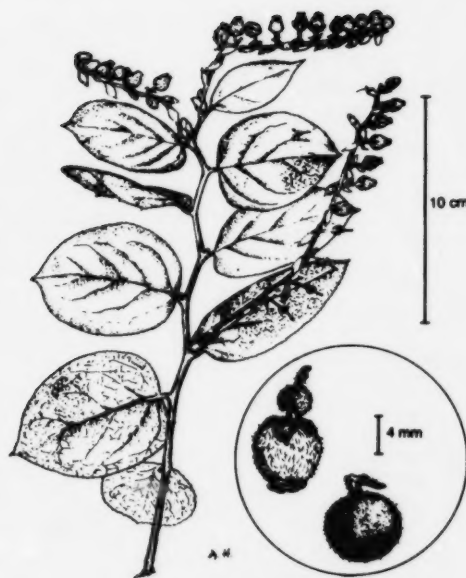
- Seeds readily germinate in exposed mineral soil.
- Fragmentation of the root system produces many new plants and stimulates production of new shoots.
- Mechanical site preparation is not considered to be an effective means of controlling fireweed.

Prescribed Burning

- Fireweed is highly favoured by burning and is more abundant on burned than on unburned sites.
- Burning favours fireweed by reducing competition from other plants and providing a suitable seedbed.
- Fireweed has been observed to be more abundant on severely burned sites than on lightly burned sites, but the response to fire intensity can be expected to vary from site to site.
- Fireweed does not survive well under regimes of regular, frequent burning.

Other Treatments

- Fireweed is susceptible to heavy or continued grazing.



Gautheria shallon (salal).



Distribution of *G. shallon* in British Columbia.

Gaultheria shallon

SALAL

Overstory Removal

- Salal does not increase or decrease significantly in abundance or cover immediately following logging.
- Logging disturbance or damage stimulates sprouting.
- Abundance and cover gradually increase over time and the plant can become the dominant species on many sites.
- Thinning will cause an increase in the vigour and cover of a salal understory if the amount of light penetrating the canopy increases significantly.

Manual Treatments

- Regrowth following cutting is slow. The extent and speed of recovery depend on the size and vigour of the plant at the time of treatment.
- Salal normally takes 1-4 years to return to pretreatment levels following cutting.
- Cutting causes an increase in stem density.

Chemical Treatments

- Salal appears to be resistant to all the herbicides used in forestry practices in British Columbia. Velpar may partially control salal, but more study is required.
- Salal can be controlled with Tordon.
- Herbicides in diesel or oil-in-water carriers have been more effective because of their ability to penetrate the thick waxy leaves and the bark. Budbreak sprays have been more successful than foliar sprays.
- Following applications of Roundup, salal has been observed to invade areas left vacant by susceptible plants.

Mechanical Site Preparation

- There is very little information available on the mechanical control of salal.
- Treatment efforts have sought techniques that will break up the root system, in the hope that this will retard regrowth. Treatments using brush rakes, straight and V-shaped blades, and backhoes have produced variable results.
- Fragmentation of the root and rhizome system can multiply the number of plants on the site.

Prescribed Burning

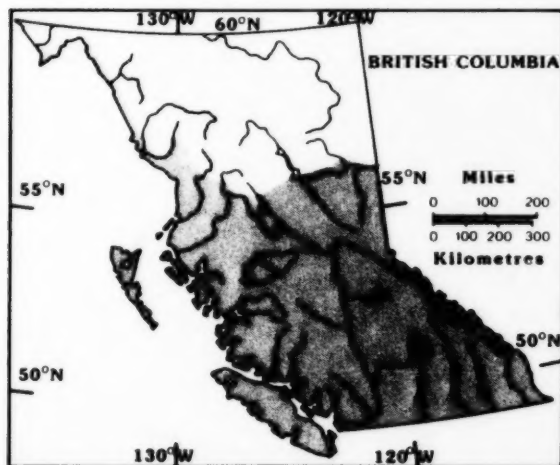
- The effects of prescribed burning on salal cover appears to be related to the moisture conditions at the time of burning.
- Burning successfully controls salal on dry sites where heat penetrates the soil and kills underground organs. An intense burn on a dry site can eliminate the species but is unlikely to do so without causing site degradation.
- Burning is less effective on moist sites with deep soil.

Other Treatments

- Nitrogen fertilization is likely to increase leaf production and plant biomass but does not usually stimulate major increases in shoot and root growth.



Lonicera involucrata (black twinberry).



Distribution of *L. involucrata* in British Columbia.

Lonicera involucrata

BLACK TWINBERRY

Overstory Removal

- Abundance and cover will remain constant or increase following harvesting. Expect an increase on moist, productive sites.
- The crowns of individual plants usually fill out and become bushier following canopy removal.
- Seeding-in may occur on sites with moisture and nutrient regimes similar to those of sites where twinberry was present in the understory prior to logging.

Manual Treatments

- There are no studies of the response of black twinberry to manual cutting.
- Sprouting, and possibly suckering, will occur following cutting. Sprouting vigour is unknown.

Chemical Treatments

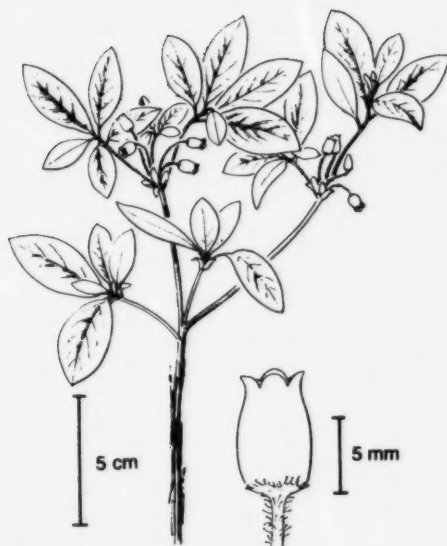
- Roundup appears to provide good to excellent control as a foliar spray at rates of 1.5-2.5 kg a.i./ha, however only a couple of studies have been done.
- Velpar may control black twinberry; further study is required.

Mechanical Site Preparation

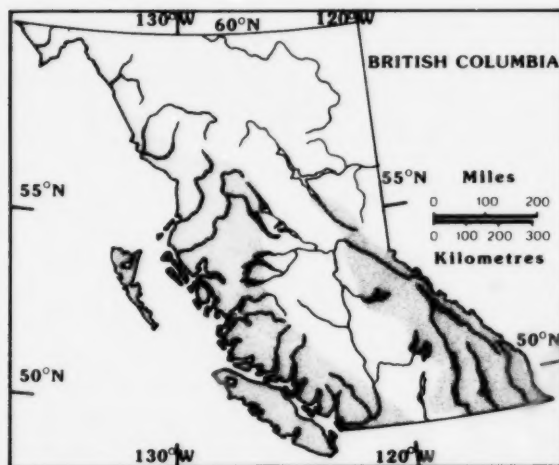
- Because this species is a seedbanker, soil disturbance may stimulate germination of stored seed.
- It may be helpful to break up the root system with a discing or ripping treatment.
- There are no studies to verify these assumptions.

Prescribed Burning

- Black twinberry is apparently set back by burning and recovers fairly slowly, especially if the fire is intense.
- There are no studies documenting this observation.



Menziesia ferruginea (false azalea).



Distribution of *M. ferruginea* in British Columbia.

Menziesia ferruginea

FALSE AZALEA

Overstory Removal

- Abundance and cover remain fairly constant following harvesting.
- If there are no further treatments following canopy removal, expect a gradual increase in cover until the plant is overtopped by trees.

Manual Treatments

- No studies of manual treatments have been carried out.
- False azalea is likely to sprout from the stem base following cutting. Sprouting is not expected to be vigorous, but no information is available.

Chemical Treatments

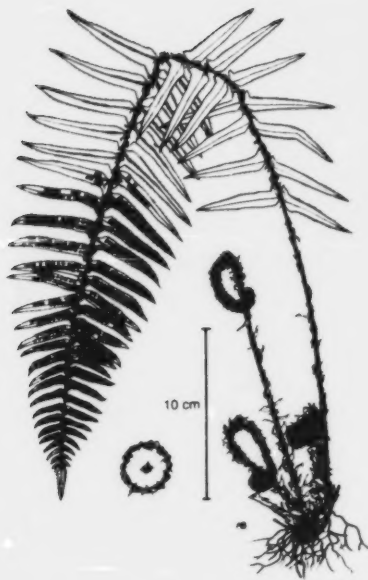
- Very little information available.
- In a trial near Blue River, B.C., false azalea remained dwarfed and deformed 2 years after a late July Roundup application by Micron Herbi at 500 g a.i./ha.
- In Oregon, false azalea was reported to be tolerant of Roundup.
- Garlon may provide more effective chemical control.

Mechanical Site Preparation

- Damaged stems are expected to sprout.
- Seeding-in is unlikely to be significant.
- There are no studies available that document the effects of mechanical site preparation on false azalea.

Prescribed Burning

- False azalea is a fire-sensitive plant. Survival is low following burning.
- Regrowth of surviving plants is slow and cover will remain significantly below preburn levels for many years.



Polystichum munitum (sword fern).



Distribution of *P. munitum* in British Columbia.

Polystichum munitum

SWORD FERN

Overstory Removal

- Numerous studies have monitored the response of sword fern following canopy removal. Results have been variable, but no studies report a dramatic increase or decrease in abundance or cover. Slight increases, slight decreases, and no change at all have been recorded.
- Response may be related to moisture conditions following harvesting. Sword fern will probably maintain or increase its cover and vigour only on those microsites where it does not experience significant summer moisture stress.

Manual Treatments

- No information available.
- Fronds have determinate growth and will not grow back. An underground rhizome allows new fronds to emerge early in the growing season.

Chemical Treatments

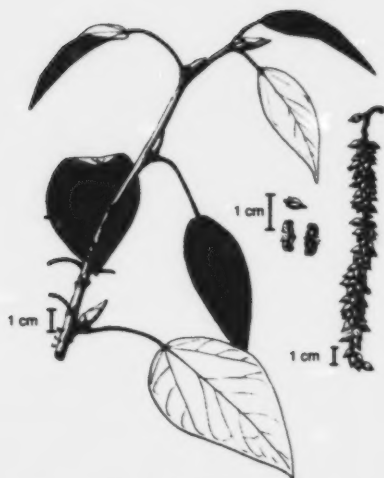
- Very little information available.
- Sword fern was severely damaged by late summer Roundup applications in western Oregon; damage was only moderate when sword fern was treated in the fall. Rates of 3-5 kg a.i./ha were used.

Mechanical Site Preparation

- Techniques that remove the plant from the ground will result in nearly total elimination of the species from the site.
- Brush blade scarification totally eliminated sword fern from a study site in Oregon.
- Sword fern was only present on undisturbed microsites following scarification of several sites near Vancouver, B.C.

Prescribed Burning

- Variable responses to burning have been reported.
- Most studies report a slight or significant decrease in frequency following burning. Recovery is slow.
- On some sites, burning may have no impact on cover.
- On other sites, burning may stimulate vigorous resprouting, resulting in an increase over preburn levels.
- Fire intensity and local site conditions are probably the most important factors controlling sword fern response. Severe fires on dry or shallow soils will eliminate or dramatically reduce sword fern cover and frequency.



Populus balsamifera ssp. *balsamifera* (balsam poplar).



Distribution of *P. balsamifera* in British Columbia. The dashed line indicates the approximate boundary between ssp. *balsamifera* (balsam poplar) to the north and east, and ssp. *trichocarpa* (black cottonwood) to the south and west. Specimens intermediate between the two subspecies are common where their ranges overlap.

***Populus balsamifera* ssp. *balsamifera* BALSAM POPLAR**

Overstory Removal

- Balsam poplar is normally part of the overstory canopy and is either cut during logging or left standing.
- In either case, the number of stems can increase dramatically following harvesting.
- An Alaskan study monitored regeneration following summer, fall, and winter logging of mature balsam poplar. The main findings were:
 1. More than 50% of stumps produced sprouts regardless of cutting season.
 2. Stump sprouting was most pronounced on winter logged areas.
 3. An individual stump can produce as many as 50 to 60 sprouts.
 4. Sprout mortality was low on fall and winter logged areas.
 5. After 4 years on the summer logged areas only 15% of the stumps still had live sprouts.
 6. Sprouts originated from dormant buds or callus tissue; sprouts from dormant buds were more common on winter logged areas.
 7. Root suckering occurred on all areas; soil disturbance enhanced suckering.
- Other forms of regeneration not described above include regeneration of buried branch pieces, and seeding-in on areas of exposed mineral soil.
- Suckering is probably the dominant form of regeneration, but seedling establishment is also common.

Manual Treatments

- For young balsam poplar that become established following harvesting, there are no studies available documenting the effects of tree age, cutting height or angle, season of cut, or multiple cuttings on stem mortality and sprout and sucker vigour.
- There is no information about the effect of girdling on balsam poplar. It will probably react in a similar manner to aspen.

Chemical Treatments

- Roundup as a mid- to late summer foliar spray at 2.4-3 kg a.i./ha has provided good to excellent control with high mortality and little suckering.
- Velpar as a liquid spray, by soil injection, or by granular application has also generally provided good control. Variable results have occurred on areas with deep organic layers.
- Balsam poplar is quite resistant to 2,4-D, but 1- or 2-year-old suckers may be considerably more susceptible.

Mechanical Site Preparation

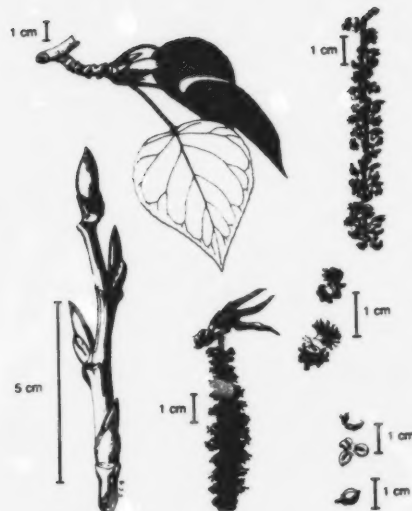
- Mechanical site preparation that exposes areas of mineral soil provides an excellent seedbed for balsam poplar seed.
- Only freshly deposited seed will germinate.
- Exposing mineral soil will promote suckering if residual balsam poplar is present.

Prescribed Burning

- Burning will stimulate root suckering and prepare a good seedbed for seedling establishment.
- Suckering may be most intense in the 2nd year after burning.
- Moderate to severe burns may reduce stump sprouting.
- Burned areas generally have greater densities of balsam poplar than unburned areas.

Other Treatments

- Burning of young poplars followed by a midsummer spray of the resulting suckers with 2,4-D ester provided better control than either burning or spraying alone.



Populus balsamifera ssp. *trichocarpa* (black cottonwood).



Distribution of *P. balsamifera* in British Columbia. The dashed line indicates the approximate boundary between ssp. *balsamifera* (balsam poplar) to the north and east, and ssp. *trichocarpa* (black cottonwood) to the south and west. Specimens intermediate between the two subspecies are common where their ranges overlap.

Populus balsamifera
sap. trichocarpa

BLACK COTTONWOOD

Overstory Removal

- Logging of mature black cottonwood will produce vigorous stump sprouts.
- Cottonwood sprouts usually grow faster than any other vegetation on a newly logged site.
- Broken stem or root parts incorporated into the soil during logging operations may also regenerate.
- Rapid seeding-in may occur on areas of disturbed soil, especially if mature trees are left standing.

Manual Treatments

- Cottonwood will sprout vigorously regardless of the season when it is cut. Sprouting tends to be somewhat less if cutting takes place during the growing season. In one study, maximum sprouting occurred on stems cut between November and February.
- Cottonwood continues to sprout vigorously even after repeated cutting (e.g. five times in 10 years).
- Cutting height and angle do not appear to affect initial sprouting vigour of cottonwood.
- Manual treatments are not considered an effective means of reducing cottonwood frequency and cover.

Chemical Treatments

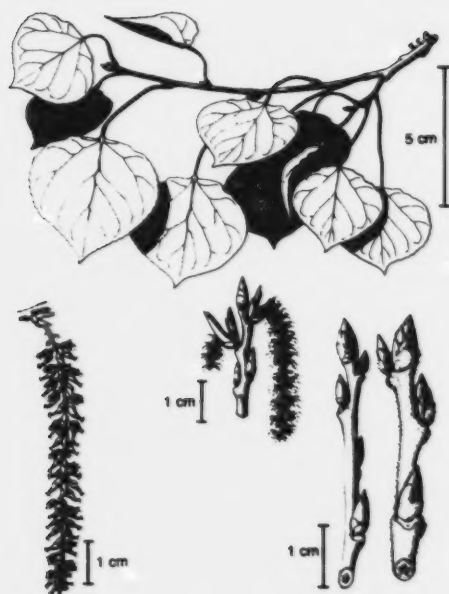
- Cottonwood appears to be extremely sensitive to Roundup at rates of 1 kg a.i./ha or more.
- 2,4-D ester causes some top-kill, with little lasting control.

Mechanical Site Preparation

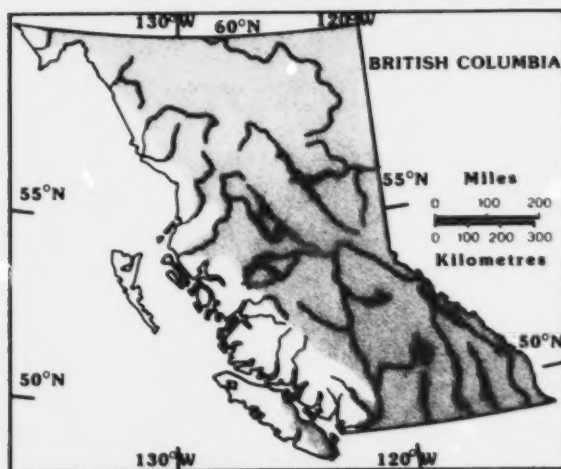
- Information on the effectiveness of mechanical site preparation in controlling black cottonwood is limited.
- Treatments that expose areas of moist mineral soil will create favourable environments for germination of seed from residual or nearby trees. Cottonwood produces a large seed crops each year.
- Fragments of stems and roots incorporated into the mineral soil through site preparation readily regenerate in moist soil.

Prescribed Burning

- Black cottonwood will sprout following burning.
- There is no information available documenting the vigour of sprouting following burning, or the impact of burning intensity on sprout vigour.



Populus tremuloides (trembling aspen).



Distribution of *P. tremuloides* in British Columbia.

Populus tremuloides

TREMBLING ASPEN

Overstory Removal

- Logging of mature aspen results in profuse root suckering accompanied by minor stump sprouting.
- It is not uncommon to get 80 000 stems per hectare of aspen suckers in the first growing season following logging of a mature aspen stand.
- The regeneration consists of numerous small clumps of extremely dense suckers. The intense competition between these suckers leads to rapid natural thinning. Within 10 years following overstory removal, a clump can be reduced to a single living stem.
- Residual aspen left standing after logging of a dominantly coniferous stand will also produce large numbers of suckers. The density of suckers depends, at least in part, on the amount of soil disturbance accompanying harvesting operations.

Manual Treatments

- If management objectives are to minimize the number of suckers produced per treated stem, it is better to girdle aspen than to cut it down. Cut trees can produce more than twice as many suckers as girdled trees. Girdling of a 55-year-old stand resulted in 1910 stems per hectare after 4 years. Sucker density on an adjacent cut area was 32 617 stems per hectare.
- Most girdled trees die within 1-4 years.
- Few studies have documented the effect of season of treatment on aspen suckering. Results of existing studies are contradictory. Girdling or cutting during the active growing season should minimize suckering.
- Regardless of method or season, manual cutting will result in an increase in the number of stems over pretreatment levels.
- The above observations refer to situations where no overstory canopy exists after treatment. In a study where cull trees were girdled within a stand of aspen, none of the girdled trees produced suckers and all treated trees died within 4 years, most within 2 years.
- Manual cuttings are not recommended for reducing the frequency or cover of young aspen suckers that develop following logging or site preparation.
- Advance girdling of mature aspen in predominantly coniferous stands may be quite successful, provided that the remaining conifers produce enough shade to retard suckering.

Chemical Treatments

- Roundup applied as a foliar spray or as a hack-and-squirt treatment should control aspen. Mid- to late summer foliar sprays at 2.4-3 kg a.i./ha have provided excellent control near Prince George, B.C. Mortality rates were high with little suckering. A hack-and-squirt treatment in New Brunswick of 20% solution Roundup at 2 ml/7.5 cm dbh killed or seriously injured all trees.
- Velpar should also control aspen either by liquid spray, soil injection, or granular application. Expect more variable results as soil organic layers become deeper.

- Results with 2,4-D foliar sprays have been variable; generally top-kill occurs followed by suckering. Rates of 4 kg a.i./ha have caused almost complete mortality and minimal suckering.
- Hack-and-squirt treatments with Velpar should control aspen, results with 2,4-D have been variable.

Mechanical Site Preparation

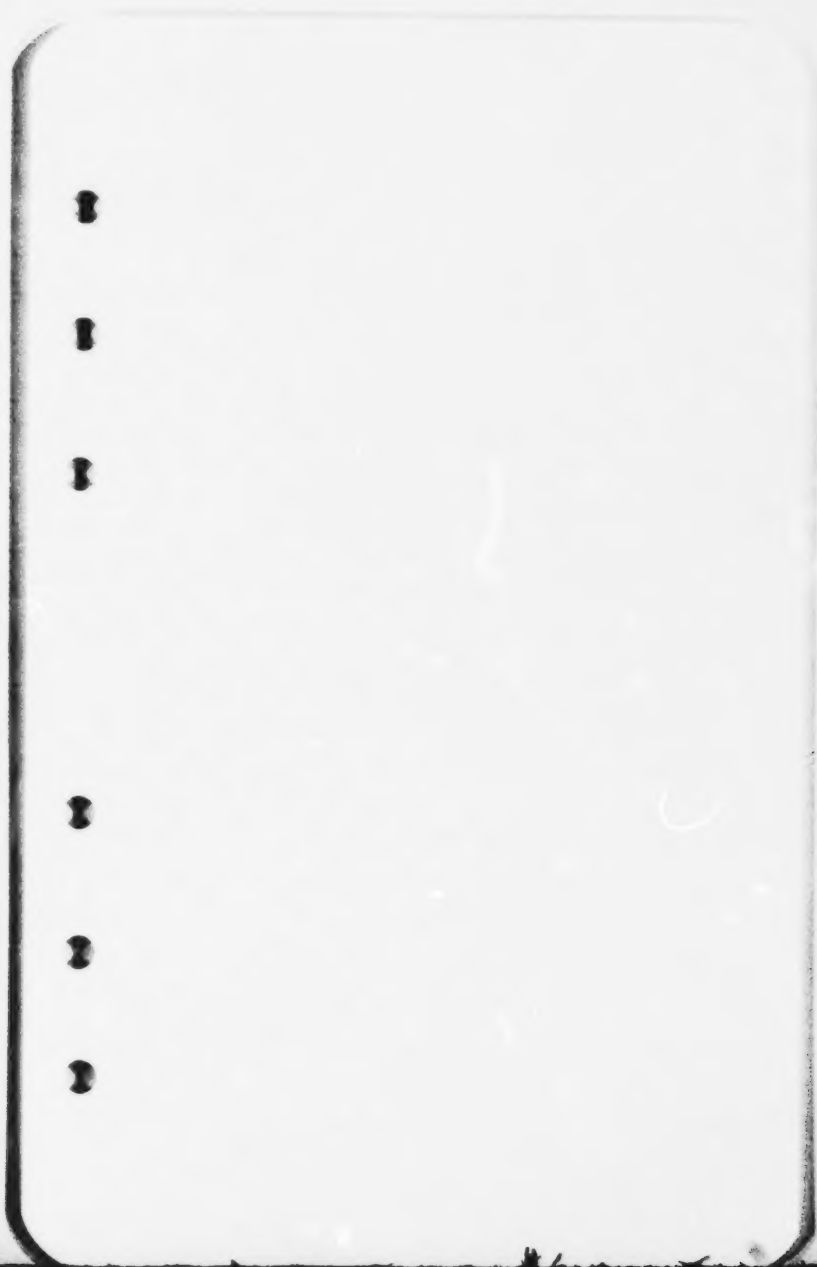
- Mechanical treatments that expose mineral soil to sunlight will stimulate suckering by increasing root temperatures.
- Seedling establishment is negligible even on moist mineral soil seedbeds.
- Mechanical site preparation will not be successful in reducing the frequency and cover of aspen unless severe treatments are used that remove the upper layer of soil.
- Intensive agricultural-style land-clearing operations have produced variable results when applied to silvicultural control of aspen.
- In northern Ontario, scarification of 1- to 4-year-old aspen suckers with shark fin barrels and anchor chain drags produced no significant reduction in aspen density.

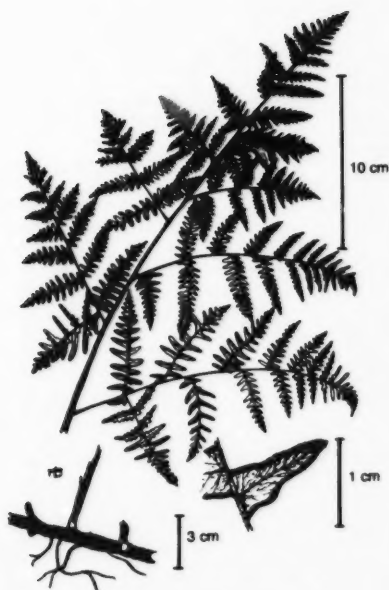
Prescribed Burning

- Burns of moderate to severe intensity will maximize the number of suckers produced. A light burn that damages but does not kill standing aspen will produce the fewest suckers.
- Severe burns increase the depth at which suckering is initiated on the root system.
- Burned stumps are less likely to sprout than unburned stumps.
- Frequent, repeated fires will eventually reduce the vigour of aspen suckering.

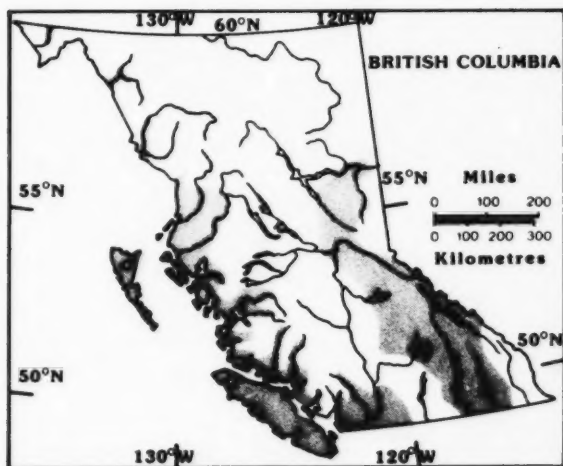
Other Treatments

- Burning of young poplars followed by a midsummer spray of the resulting suckers with 2,4-D ester provided better control than either burning or spraying alone.
- Aspen is not tolerant of sheep grazing and can be virtually eliminated from a site after 3 years of heavy summer-long use.
- Cattle grazing does not severely retard aspen growth.





Pteridium aquilinum (bracken).



Distribution of *P. aquilinum* in British Columbia.

Pteridium aquilinum

BRACKEN

Overstory Removal

- If bracken is present in the forest understory prior to harvesting, it will expand rapidly by rhizomatous growth.
- Bracken will invade virtually any unoccupied habitat.
- Bracken may also invade older clearcuts.
- Bracken cover can increase significantly following thinning of a conifer overstory.

Manual Treatments

- Bracken sends up new fronds following cutting.
- Bracken can be cut many times in one growing season and will still produce new fronds the next year.
- Manual treatments will provide only short-term relief from bracken competition unless they are repeated at frequent regular intervals.

Chemical Treatments

- Roundup has given variable results. Some trials report top-kill followed by sprouting the next year. Fall applications in western Oregon have provided effective control. Bracken was considered 70% controlled one growing season after a July aerial spray of 2.25 kg a.i./ha near Prince George, B.C.
- Chemicals must act on the rhizome system to be effective.
- Asulam is reported to kill bracken at rates of 2-6 kg a.i./ha.

Mechanical Site Preparation

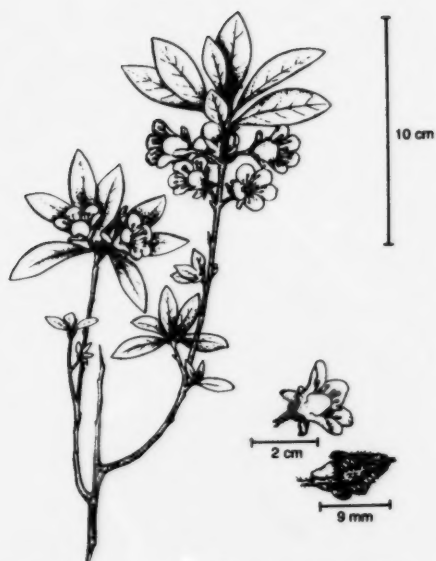
- Most mechanical treatments maintain or increase the frequency and cover of bracken.
- Damage to the rhizome system stimulates sprouting and fragmentation creates new plants.
- Repeated deep plowing or disking can be effective, but may not work in areas of high summer rainfall.

Prescribed Burning

- Bracken sprouts vigorously following fire and rapidly returns to, or exceeds, preburn levels.
- Bracken expands into vacant areas created by burning; sterile burned soil is an ideal substrate for spore germination.
- Bracken will continue to increase in frequency and cover until it is overtopped by other species.

Other Treatments

- Trampling by cattle is widely used as a means of control in agricultural areas, but bracken is toxic to cattle.
- Bracken responds to fertilization with increased sprouting and rhizome growth. When present in the understory of fertilized Douglas-fir stands it will tie up some of the nitrogen, but this is not seen as a problem unless soils are very nitrogen-deficient.



Rhododendron albiflorum (white-flowered rhododendron).



Distribution of *R. albiflorum* in British Columbia.

Rhododendron albiflorum

**WHITE-FLOWERED
RHODODENDRON**

Overstory Removal

- Major changes in cover are not expected following harvesting.
- Individual plants will increase somewhat in size and vigour.
- Plants damaged during logging activities are set back for several years.
- There are no studies to verify these observations.

Manual Treatments

- There are no studies that document the effects of manual treatments on this plant.
- Rhododendron will probably sprout back following cutting and regain its pretreatment level within several growing seasons.
- There is no information regarding the number of sprouts produced or the effects of season of cutting and multiple cutting on sprouting vigour.

Chemical Treatments

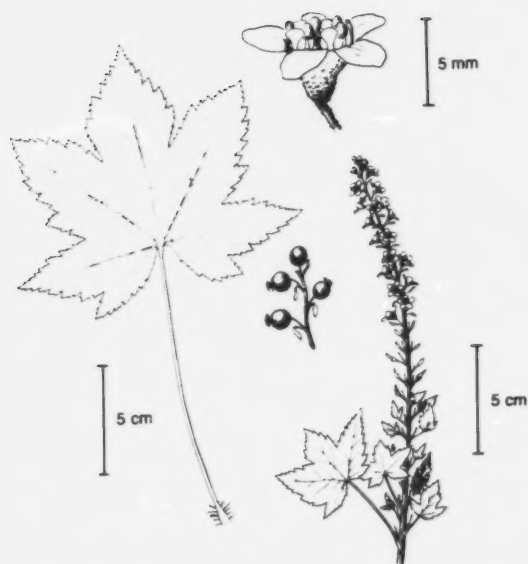
- Rhododendron is considered to be fairly tolerant of Roundup, but cover was apparently reduced at a test site near Blue River, B.C.
- Garlon may be a more effective chemical.
- There is no other information available.

Mechanical Site Preparation

- There is no information on the effects of mechanical site preparation on rhododendron.
- Seedling establishment on areas of exposed mineral soil is expected to be insignificant.
- Recovery from treatments that physically uproot the plant will probably be slow.

Prescribed Burning

- Fires of moderate to severe intensity will set back rhododendron for up to 7-10 years.
- There are no studies to verify these observations.



Ribes bracteosum (stink currant).



Distribution of *R. bracteosum* in British Columbia.

Ribes bracteosum

STINK CURRANT

Overstory Removal

- Stink currant apparently goes through an initial period of shock immediately following canopy removal. After recovery, it increases significantly in size, but rarely in height.
- The number of stems may increase slowly by seeding-in and layering.
- The degree of soil disturbance associated with logging does not appear to have a significant effect on stink currant response.

Manual Treatments

- Stink currant sprouts rapidly following cutting and can return to pretreatment levels within 1 year.
- There are no studies documenting the number of sprouts produced or the effects of cutting season and multiple cutting on sprouting vigour.

Chemical Treatments

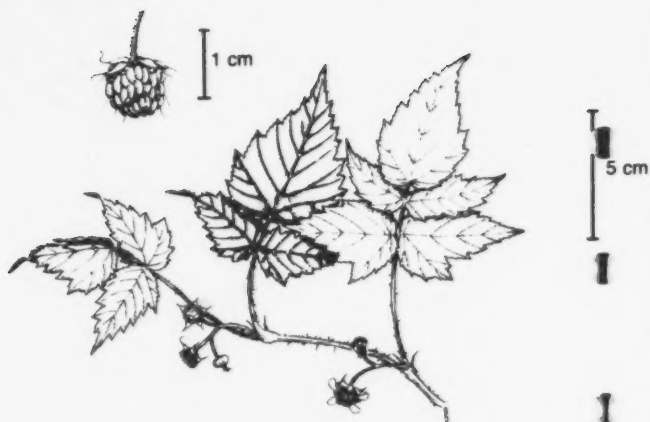
- 2,4-D and Roundup will usually kill the aerial parts of stink currant. Most plants will sprout back.
- Stink currant is thought to be more resistant to the registered chemicals than associated *Rubus* species.
- There are no studies documenting the effects of chemical treatments on stink currant.

Mechanical Site Preparation

- No information available.
- Currants are seed-banking species, and exposure of moist mineral soil may create favourable conditions for germination of stored seed.
- Damaged stems will probably sprout back.

Prescribed Burning

- Stink currant sprouts back after fire. It can take up to 2-3 years to return to pretreatment levels.



Rubus idaeus (red raspberry).



Distribution of *R. idaeus* in British Columbia.

Rubus idaeus

RED RASPBERRY

Overstory Removal

- Red raspberry is usually absent from the mature forest.
- Invasion is particularly intense in heavily disturbed areas such as landing piles and roadsides.
- Raspberry frequently does not become established until 3-5 years following harvesting. If the site is quickly taken over by other species during this time, it will not be able to compete.

Manual Treatments

- Raspberry canes have a 2-year lifespan only; manual treatments cannot have a lasting effect unless they are repeated at frequent regular intervals.
- Cutting stimulates both basal sprouting and root suckering.
- Cutting will increase the vigour of vegetative growth for the first growing season.

Chemical Treatments

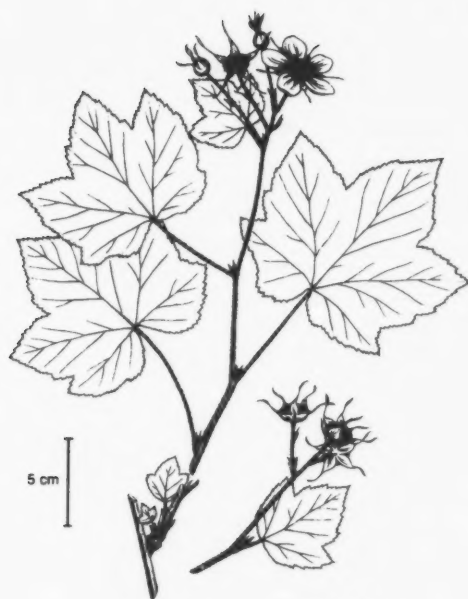
- Red raspberry is tolerant of 2,4-D.
- Results with Roundup have been variable, ranging from top-kill followed by sprouting and suckering to total mortality. In the Prince Rupert Forest Region, best results were obtained with a late summer application.
- Red raspberry may be quite sensitive to Velpar at rates of 2-5 kg a.i./ha; further study is needed.

Mechanical Site Preparation

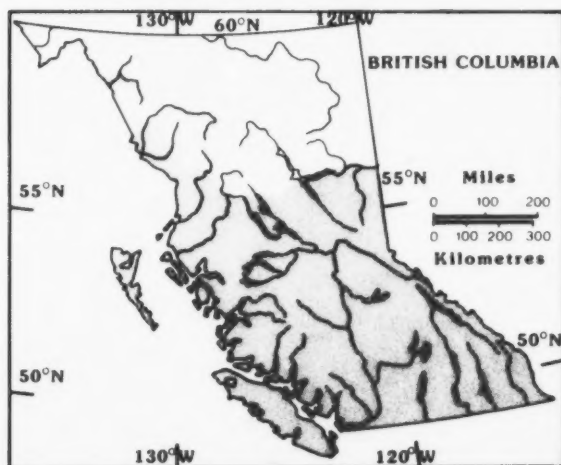
- There are no studies documenting the effects of mechanical site preparation on red raspberry.
- Most mechanical treatments will probably increase raspberry abundance.
- Raspberry seed readily germinates in areas of exposed mineral soil.
- Fragmentation of the root and rhizome system produces new plants.

Prescribed Burning

- Red raspberry is usually more abundant on burned areas than on unburned areas.
- Burning stimulates sprouting and suckering of existing plants, stimulates germination of buried seed, and provides a suitable seedbed for germination of newly deposited seed. The absence of competing plants immediately following fire also favours raspberry expansion.
- Vegetative parts of red raspberry are thought to be very resistant to heat damage.



Rubus parviflorus (thimbleberry).



Distribution of *R. parviflorus* in British Columbia.

Rubus perviflorus

THIMBLEBERRY

Overstory Removal

- On areas where thimbleberry is present prior to harvesting it will rapidly expand in frequency and cover.
- Thimbleberry can double or triple its cover in 5 years.
- Thimbleberry increase is due to a combination of sprouting, suckering, and seedling establishment.
- It can invade areas of soil disturbance with seed carried in by animals or stored in the forest floor.
- It does not normally invade ecosystems that are significantly drier and poorer than those where it is present under the forest canopy.

Manual Treatments

- Rapid sprouting and suckering follow cutting.
- In an Oregon study, thimbleberry grew 75-100 cm in the 1st year following cutting regardless of the cutting season (dormant, early summer, late summer).
- The density and leaf area of the thimbleberry canopy increases following cutting.
- Thimbleberry can be cut two or three times in one growing season and will still come back the following year.
- Manual treatments are not considered an effective means of reducing the frequency and cover of thimbleberry.

Chemical Treatments

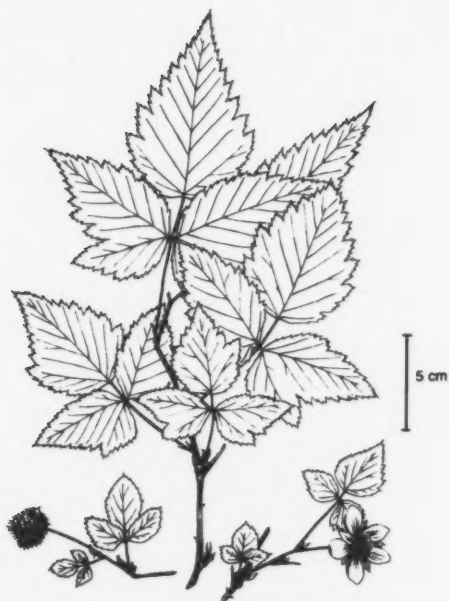
- 2,4-D is usually ineffective against thimbleberry, especially in coastal environments. In northeastern Oregon and northern Idaho, 2,4-D in an oil-and-water carrier caused severe damage.
- Roundup is considered more effective than 2,4-D. Results with Roundup in British Columbia vary from top-kill followed by basal sprouting the next season, to total mortality at rates of 1-3 kg a.i./ha.
- Thimbleberry is less susceptible to Roundup than salmonberry.
- Thimbleberry is quite resistant to Velpar.

Mechanical Site Preparation

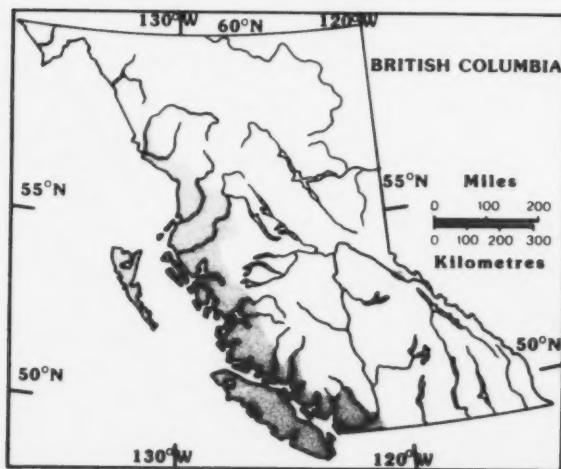
- Thimbleberry rapidly invades areas of disturbed soil and has been observed to increase following scarification.
- Soil disturbance stimulates germination of stored seed and provides a suitable seedbed for freshly deposited seed.
- Plants damaged by mechanical treatments will rapidly sprout or sucker.

Prescribed Burning

- Thimbleberry is usually most abundant on burned sites.
- Thimbleberry rapidly sprouts and suckers after fire.
- Light burns can stimulate germination of buried seeds.
- The rate of recovery is affected by fire intensity. Recovery can be slow after a hard burn.
- Burning can reduce thimbleberry abundance on mesic ecosystems or sites with coarse soil textures where heat from the fire is effectively transmitted to the roots.



Rubus spectabilis (salmonberry).



Distribution of *R. spectabilis* in British Columbia.

Rubus spectabilis

SALMONBERRY

Overstory Removal

- In areas where salmonberry is present prior to harvesting, it will rapidly expand in frequency and cover following overstory removal.
- Expansion is primarily by means of rhizomatous suckers and germination of buried seed.
- Seedling germination is enhanced by soil disturbance accompanying logging.
- Where salmonberry is not present prior to logging, it can invade areas of disturbed soil with seed carried in by animals or by germination of long-buried seed.
- Salmonberry is an aggressive invader and frequently becomes the dominant species on moist sites that were disturbed during logging operations.
- Salmonberry can increase significantly in the understory following thinning of conifer stands.

Manual Treatments

- Salmonberry rapidly sprouts and suckers following cutting.
- Most stems produce two or three sprouts each. Season of cutting apparently has no effect on the number of sprouts produced.
- In an Oregon study, growth of sprouts was significantly less on stems cut early in the growing season than on those cut when dormant; neither treatment succeeded in reducing competitive stress on conifers.
- Salmonberry stem density and leaf area increases after cutting.
- Multiple cuttings in one growing season do not appear to reduce the vigour of vegetative reproduction the following year.
- Manual treatments are not considered a viable method of reducing salmonberry frequency or cover.

Chemical Treatments

- Salmonberry is resistant to 2,4-D.
- Roundup applied as a foliar spray at 1-3 kg a.i./ha usually gives excellent control of salmonberry. All above-ground parts are killed and little subsequent sprouting or suckering occurs.
- Salmonberry tends to be more sensitive to late foliar sprays than to early foliar sprays.
- An Oregon study found that plants damaged by logging operations were less susceptible to Roundup than undamaged plants.

Mechanical Site Preparation

- Unless it is severe enough to remove surficial soil layers, mechanical site preparation will probably increase the frequency of salmonberry.
- Damaged or flattened stems can sprout, sucker, or layer.
- Stem fragments incorporated into the soil frequently root and produce new colonies.
- Exposure of mineral soil can stimulate germination of buried seed.

Prescribed burning

- Germination is similar on burned and unburned sites, but severe fires can reduce the frequency of surviving seedlings.
- Salmonberry seems to be more sensitive to fire than thimbleberry. Unlike thimbleberry, its frequency and cover are usually similar or slightly less on burned sites than on unburned areas.
- Fire can be successfully used to control salmonberry expansion on mesic ecosystems or on sites with coarse-textured soils where heat from the fire is effectively transmitted to the root system.



Salix bebbiana (Bebb's willow).



Distribution of willows (*Salix* spp.) in British Columbia.

Salix spp.

WILLOWS

There are many different species of willow on forested sites in B.C. Responses to silvicultural practices can vary a great deal between species and even within a species. The following are generalized comments relating to the typical behaviour of some common willow species.

Overstory Removal

- Frequency and cover generally increase following harvesting.
- The increase is usually slow unless soil disturbance and damage to existing plants have been extensive.
- Individual plants will fill out and become much larger following release.
- Cut or damaged plants will produce sprouts.

Manual Treatments

- Willow will sprout vigorously when cut, regardless of cutting season; plants cut during the dormant season sprout more vigorously.
- The number of sprouts per cut stem can vary from only one or two to as many as 60.
- Willow sprouts can grow 2-3 m in the first growing season; willows cut in July can produce sprouts that are 1 m tall by the end of that growing season.
- No specific studies are available that monitor the influence of cutting season, height and angle of stump, plant age, and multiple cuttings on sprouting vigour.
- There is no information describing the response of willow to girdling. It seems likely that willows would respond to girdling by sprouting.
- Manual treatments are usually used to increase production of willow browse and are not considered an effective means of reducing frequency and cover.

Chemical Treatments

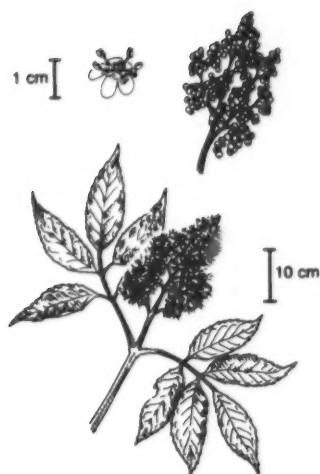
- Chemical treatments have produced variable results; one reason for this may be the difficulty of identifying individual willow species.
- 2,4-D ester as an early foliar treatment at 3 kg a.i. ha has provided good control in the Vancouver Forest Region.
- Applications of Roundup have resulted in varying degrees of defoliation generally followed by sprouting. Expect variable results.
- Velpar may provide effective control of willows, but there are few trials to confirm this.

Mechanical Site Preparation

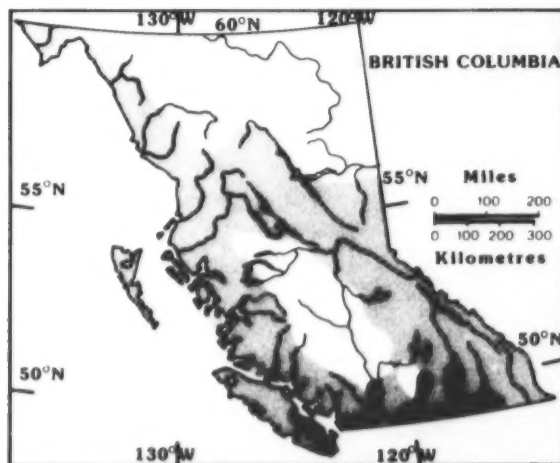
- Mechanical treatments are likely to increase the abundance of willows on a site.
- Damaged stems will sprout, broken and buried branch parts may root, and seedlings can become established on exposed mineral soil.
- Blade scarification has been successful in dramatically increasing willow browse availability.

Prescribed Burning

- Aerial parts of willows are easily killed by fire.
- Willows produce sprouts following fire, and burning usually increases willow cover within a few years.
- The vigour and intensity of sprouting may be affected by the intensity and duration of the burn.
- Eradication of willows through fire is highly unlikely; willows have been known to survive even the most intense forest fires.
- Expect variable levels of sprouting following burning.



Sambucus racemosa (red elderberry).



Distribution of elderberries (*Sambucus* spp.) in British Columbia. The shaded area represents the distribution of *S. racemosa*, while the hatched area shows the distribution of *S. cerulea*.

***Sambucus* spp.**

ELDERBERRY

Overstory Removal

- Frequency and cover of elderberry either remain constant or increase somewhat following canopy removal. No studies have reported a dramatic increase in elderberry abundance.
- Individual plants fill out and produce a broad, spreading crown.
- In an Oregon study, prolific seedlings have been reported 1 year following logging. In this case the seedlings were attributed to a large flock of pigeons distributing seeds in the area. Seed stored in the forest floor may also be stimulated to germinate by canopy removal and logging disturbance.

Manual Treatments

- Rapid sprouting follows cutting. Some plants from the Interior of B.C. also produce rhizome suckers.
- A sprout can grow up to 3/4 of its full height in the first growing season after cutting. Elderberry is considered to be one of the fastest sprouting species, in terms of sprout height and vigour, in the Pacific Northwest states.
- Two to five sprouts are typically produced for each cut stem. In Oregon, cutting during dormancy or early in the summer produces fewer sprouts than late summer cutting.
- The plant cannot withstand repeated heavy clipping, but the potential for regrowth is not affected when cutting occurs only once at the end of each growing season.

Chemical Treatments

- 2,4-D will sometimes kill elderberry, but it does not provide reliable control.
- Roundup is considered more reliable for controlling elderberry. Injury is usually severe with late summer or fall applications at 2-3 kg a.i./ha, however some sprouting can occur.

Mechanical Site Preparation

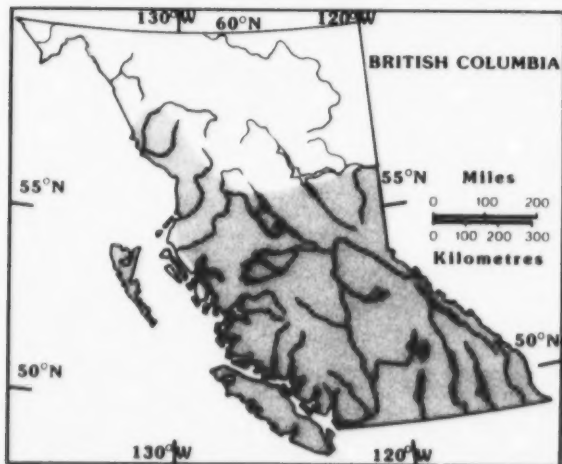
- Very little information available.
- An Oregon study reported more than 50% mortality following brush blade scarification. Some injured plants sprouted.
- Mechanical treatments must uproot plants to be effective.
- Soil disturbance provides a suitable seedbed, and may stimulate germination of stored seed.

Prescribed Burning

- Elderberry will sprout back following fire unless fires are severe enough to kill the root system.
- Fire can stimulate germination of stored seed.
- Variable changes in cover and frequency have been reported following fire.



Symphoricarpos albus (snowberry).



Distribution of *S. albus* in British Columbia.

Symphoricarpos albus

SNOWBERRY

Overstory Removal

- Snowberry increases in both frequency and cover following harvesting. The increase can be slight or quite dramatic depending on local conditions.
- Increases in abundance occur through suckering, and germination of buried or fresh seed.

Manual Treatments

- Snowberry is a rhizomatous species that suckers and sprouts from roots and rhizomes in response to cutting.
- There are no reports of basal sprouting.
- The rate of suckering and the effects of season of cutting and multiple cuttings on sucker vigour are unknown.

Chemical Treatments

- 2,4-D ester at 3 kg a.i./ha applied as an early foliar spray has provided excellent control. Results with 2,4-D have been poor when spraying takes place at other times of the year.
- Roundup at 1-2.5 kg a.i./ha has caused high rates of injury and mortality when applied in the spring or fall.

Mechanical Site Preparation

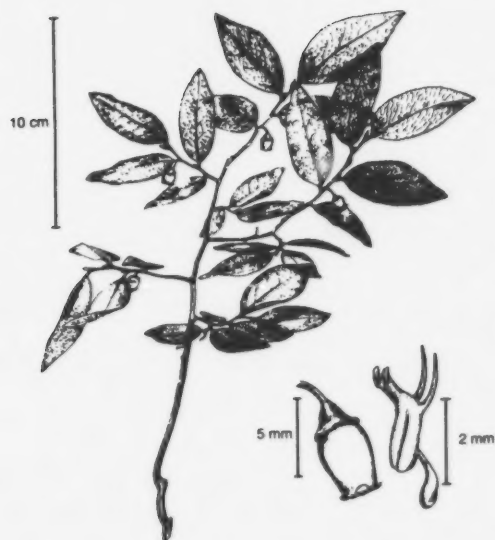
- Snowberry is a seed-banking species and stored seed can germinate following mineral soil disturbance.
- Plants damaged during mechanical treatments are likely to sucker.
- There are no studies documenting the effects of mechanical site preparation on the frequency and cover of this shrub.

Prescribed Burning

- Snowberry regenerates from roots and rhizomes following fire.
- To reduce suckering, fire intensity must be sufficient to kill the root and rhizome system.
- Variable responses to fire have been reported, but in general, light to moderate fires will increase stem density and within 3-5 years cover will exceed preburn levels.
- Regeneration from buried seed is favoured by fires of low severity and short duration that remove little of the soil organic layer.

Other Treatments

- Snowberry is commonly grazed by cattle, but is fairly resistant to heavy grazing.



Vaccinium membranaceum (black huckleberry).



Distribution of *V. membranaceum* in British Columbia.

Vaccinium membranaceum

BLACK HUCKLEBERRY

Overstory Removal

- Abundance remains static or increases slowly following canopy removal.
- Plants become more vigorous and berry production increases.
- Expansion of huckleberry patches takes place through rhizomatous growth. Seedling establishment is uncommon.

Manual Treatments

- Sprouting and suckering occur after manual cutting.
- Recovery is slow and the shrubs may take between 3 and 7 years to reach pretreatment levels.
- The number and density of stems is expected to increase following cutting.
- There is no information regarding the effect of cutting season or multiple cuttings on sprout vigour.

Chemical Treatments

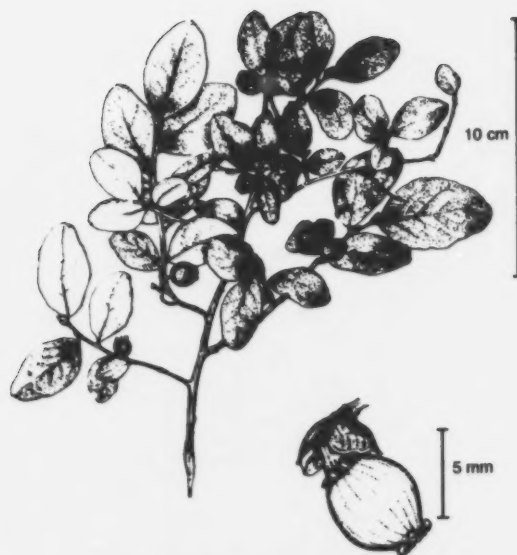
- 2,4-D ester applied as an early foliar spray will kill aerial parts, but the plant will respond by sprouting the following growing season.
- Black huckleberry is tolerant to very tolerant of Roundup.
- Simazine has little effect on black huckleberry.
- Velpar may damage black huckleberry, but little information is available.

Mechanical Site Preparation

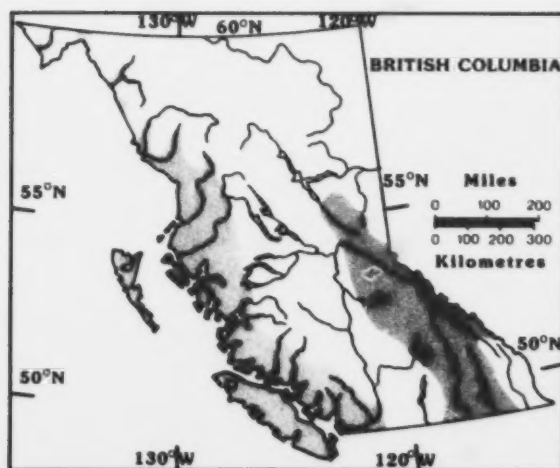
- Black huckleberry does not readily invade areas of disturbed mineral soil.
- Most mechanical treatments are likely to result in a reduction in frequency and cover for several years.
- Discing apparently stimulates rhizome sprouting.

Prescribed Burning

- Black huckleberry sprouts and suckers following burns of light to moderate severity.
- Recovery is slow and the shrub may take 3-7 years to return to pretreatment levels of cover.
- The number and density of stems can be expected to increase following light to moderate fires.
- Burns of moderate to severe intensity on coarse-textured soil or in areas with thin organic layers will cause heavy mortality by destroying the underground rhizomes.



Vaccinium ovalifolium (oval-leaved blueberry).



Distribution of *V. ovalifolium* in British Columbia.

Vaccinium ovalifolium

OVAL-LEAVED BLUEBERRY

Overstory Removal

- Oval-leaved blueberry remains at fairly constant levels following harvesting.
- Individual plants become more bushy and fruit production increases.
- Cover and frequency can slowly increase over time until the shrub is overtopped by conifers.
- Some seeding-in will occur in open habitats.

Manual Treatments

- There is no information on the effects of cutting treatments on oval-leaved blueberry.
- It is a rhizomatous species and should sprout and sucker following cutting; however, regrowth is not expected to be rapid.

Chemical Treatments

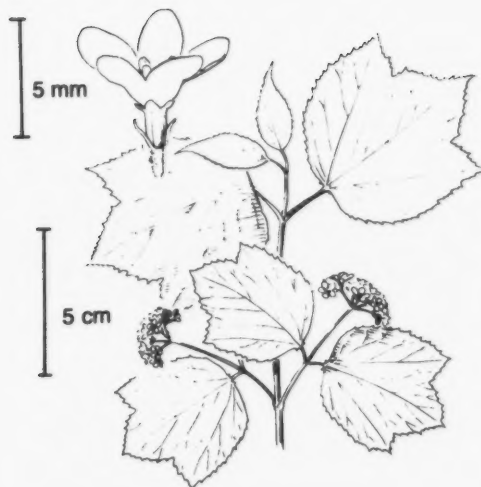
- Very little information.
- 2,4-D may defoliate oval-leaved blueberry; the plants will likely resprout.
- Roundup is unlikely to seriously affect oval-leaved blueberry.

Mechanical Site Preparation

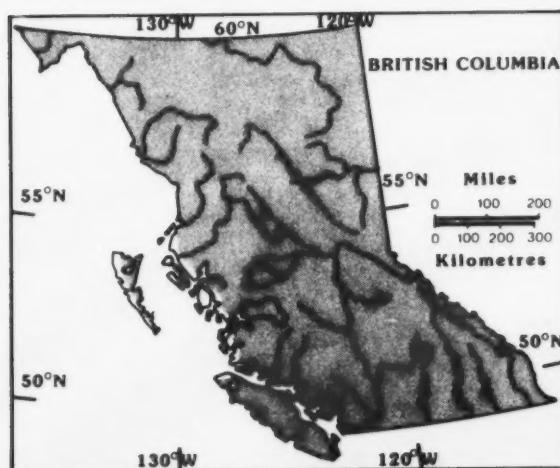
- Oval-leaved blueberry does not invade areas of mineral soil disturbance. Best seedling establishment is on organic seedbeds.
- There is no information available on the effect of mechanical site preparation on this species.

Prescribed Burning

- Frequency and cover are thought to be significantly reduced following burning.
- Recovery following burning will be primarily through vegetative reproduction, but regrowth is expected to be quite slow.



Viburnum edule (highbush-cranberry).



Distribution of *V. edule* in British Columbia.

Viburnum edule

HIGHBUSH-CRANBERRY

Overstory Removal

- The frequency and cover of highbush-cranberry remains constant or decreases slightly in the first few years following canopy removal.
- Plant vigour is expected to increase on favourable habitats, but any increase in abundance occurs slowly.

Manual Treatments

- Very little information available.
- Sprouting is expected following cutting, but regrowth is not exceptionally vigorous.

Chemical Treatments

- Very little information available.
- Roundup appears to defoliate cranberry and cause moderate to high rates of mortality.
- Highbush-cranberry is likely tolerant of Velpar.

Mechanical Site Preparation

- This is a seed-banking species, and soil disturbance is expected to favour germination of stored seed.
- Mechanical treatments may also provide a favourable seed-bed for germination of freshly deposited seed.
- Plants damaged or fragmented during site preparation can be expected to sprout back.

Prescribed Burning

- In Alaska, highbush-cranberry is one of the first species to sprout back following a fire. There is no information on the number of sprouts or their growth rates.
- Fires of light intensity and short duration that remove little of the organic layers are thought to favour germination of buried seed.

Table 4. Summary of species response to silvicultural treatments.

Species	Overstory removal	Manual treatments	Mechanical site preparation	Burning
<i>Acer glabrum</i> (Douglas maple)	Static or slow increase	Moderate sprouter following cutting	Damaged stems sprout. Seeding-in may occur on disturbed areas	Moderate to severe fires can kill plant. Light fires promote sprouting and can increase cover
<i>Acer macrophyllum</i> (bigleaf maple)	Static or increases	Sprouts vigorously from cut stump	Damaged stems sprout. Seeding establishment rare	Severe burns can kill plants. Usually sprouts back vigorously
<i>Alnus incana</i> ssp. <i>senilis</i> (mountain alder)	Increases on wet sites	Sprouts. Little information available	Seeds-in to exposed mineral soil	Set back by moderate to severe fires
<i>Alnus rubra</i> (red alder)	Rapid increase. Invades by seed	Moderate sprouter. To minimize sprouts: girdle, or cut in late summer, low flat stump. Sprouting vigour declines with age	Invades exposed mineral soil. Expect increase after treatment	Can reduce stump sprouting. Seedlings establish on exposed soil
<i>Alnus viridis</i> (Silka or green alder)	Static or slow increase	Poor sprouter. Silka alder set back by cutting	Slow invader of exposed mineral soil	Moderate burns can control this species
<i>Althya filifemina</i> (lady fern)	Increases on wet sites. Decreases on drier sites	No information	No information	Decreases cover and frequency
<i>Betula papyrifera</i> (paper birch)	Increases. Invades by seed	Moderate to vigorous sprouter. To minimize sprouts: girdle, or cut during growing season	Stimulates seeding-in, especially on mixed organic and mineral seedbeds. Damaged stems sprout	Most frequent on burned areas. Severe burn may reduce sprouting
<i>Calamagrostis canadensis</i> (bluejoint)	Increases. Invades by seed and rhizomatous growth	Not applicable	Quickly invades disturbed areas	Increases in cover and frequency. Sprouts and seeds-in vigorously
<i>Calamagrostis rubescens</i> (vinegrass)	Increases. Invades by rhizomes and seeding-in	Not applicable	Increases following soil disturbance	Increases in cover and frequency. Sprouts and seeds-in vigorously
<i>Cornus sericea</i> (red-osier dogwood)	Static or slow increase	Sprouts and suckers. Vigour can be reduced by multiple cuttings	Damaged stems sprout and sucker. Cover unlikely to change significantly	Set back by severe fires. Favoured by light fires
<i>Corylus cornuta</i> (hicknut)	Static or slow increase	Sprouts and suckers vigorously. Vigour unaffected by repeated cuttings	Deep scarification or disking can reduce sprouts and suckers	Aerial parts easily killed by fire. Vigorous regrowth expected
<i>Epilobium angustifolium</i> (fireweed)	Rapid increase. Invades by seeding-in, then spreads by suckering	Sprouts and suckers	Rapidly invades disturbed areas. Damaged parts sprout or sucker	Much more abundant on burned areas
<i>Gaultheria shallon</i> (salal)	Slow but steady increase	Sprouts and suckers. Regrowth is often slow but stem density increases	Varied response. Sets back growth but usually increases stem density	Successful control on dry sites. Not effective on wet sites
<i>Lonicera involucrata</i> (black hellebore)	Static or slow increase	Sprouts. Little information available	Little information available	Reduces abundance. Slow to recover
<i>Menyanthes trifurcata</i> (leaves only)	Static	Sprouts. Little information available	Little information available	Fire sensitive. Significantly reduced in abundance, slow to recover
<i>Populus tremula</i> (sweep fern)	Static or increases on wet sites. Static or decreases on dry sites	No information	Techniques that sprout plant will reduce abundance	Variable results depending on fire severity and soil moisture

Table 4. Summary of species response to silvicultural treatments—Continued.

Species	Overstory removal	Manual treatments	Mechanical site preparation	Burning
<i>Populus balsamifera</i> ssp. <i>balsamifera</i> (balsam poplar)	Increases. May invade by seed	Sprouts and suckers vigorously. Cut during growing season to minimize regrowth	Promotes suckering. Provides a seedbed	Stimulates suckering may retard sprouting if severe
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> (black cottonwood)	Increases. Invades by seed	Sprouts vigorously. Cut during growing season to minimize regrowth	Prepares a seedbed. Usually increases density	Stimulates sprouting. Severe burns may reduce sprouting vigor
<i>Populus tremuloides</i> (trembling aspen)	Increases. Suckers vigorously	Suckers vigorously. Girdle, or cut during growing season to minimize suckering	Promotes suckering	Promotes suckering. Density can be dramatically increased
<i>Pteridium aquilinum</i> (bracken)	Increases. Spreads rapidly by underground rhizomes	Sprouts and suckers vigorously. Frond density increases	Expect rapid regrowth. Repeated plowing is the only effective means of MSP	Invades burned areas. Sprouts and suckers vigorously. Density increases
<i>Rhododendron arbutum</i> (white-flowered rhododendron)	More-or-less static	Sprouts. Little information available	No information available	Susceptible to fires of moderate intensity. Slow to recover
<i>Ribes bracteosum</i>	Static or slow increase	Sprouts vigorously. Rapid regrowth	Little information. May promote seedling germination	Sprouts. Can take 2-3 years to recover
<i>Rubus idaeus</i> (red raspberry)	Rapid increase	Sprouts and suckers. Density increases	Germinates on exposed mineral soil. Damage causes sprouting and suckering	Invades burned areas using buried and new seed. Sprouts and suckers
<i>Rubus parviflorus</i> (thimbleberry)	Rapid increase. Invades by stored or animal-carried seed	Sprouts and suckers even after multiple cuttings. Density increases	Invades exposed mineral soil. Damaged stems sprout and sucker	Sprouts and suckers. Cover may increase. Can be set back on dry sites
<i>Rubus spectabilis</i> (salmonberry)	Rapid increase. Invades by stored or animal-carried seed	Sprouts and suckers even after multiple cuttings. Density increases	Invades exposed mineral soil. Broken stem parts may root	Sprouts and suckers. Cover may be reduced especially on drier sites
<i>Salix</i> spp. (willows)	Increases	Sprouts vigorously. Rapid regrowth. Density increases	Invades exposed mineral soil. Broken stem parts may root	Sprouts. Severity of burn significantly affects response
<i>Sambucus</i> spp. (elderberries)	Static or slow increase	Sprouts vigorously. Very rapid growth	Uprooted plants die. Little information available	Sprouts. May seed-in. Severity of burn affects response
<i>Symphoricarpos albus</i> (snowberry)	Increases. Stimulates suckering and germination of buried seed	Suckers and sprouts. Little information available	Exposing mineral soil improves seed germination	Suckers and sprouts. May stimulate seed germination
<i>Vaccinium membranaceum</i> (black huckleberry)	Static or slow increase	Sprouts and suckers. Slow to recover	Probably decreases in abundance. Little information available	Sprouts and suckers. Slow recovery. Severe fires cause mortality
<i>Vaccinium ovalifolium</i> (oval-leaved blueberry)	Static or slow increase	Sprouts, may sucker. Little information available	Does not invade exposed mineral soil. Abundance probably reduced	Abundance reduced. Slow recovery
<i>Vitumum edule</i> (highbush cranberry)	Static	Sprouts. Little information available	May stimulate germination of buried seed. Little information available	Sprouts. Little information available

Table 5. Effectiveness of registered herbicides.

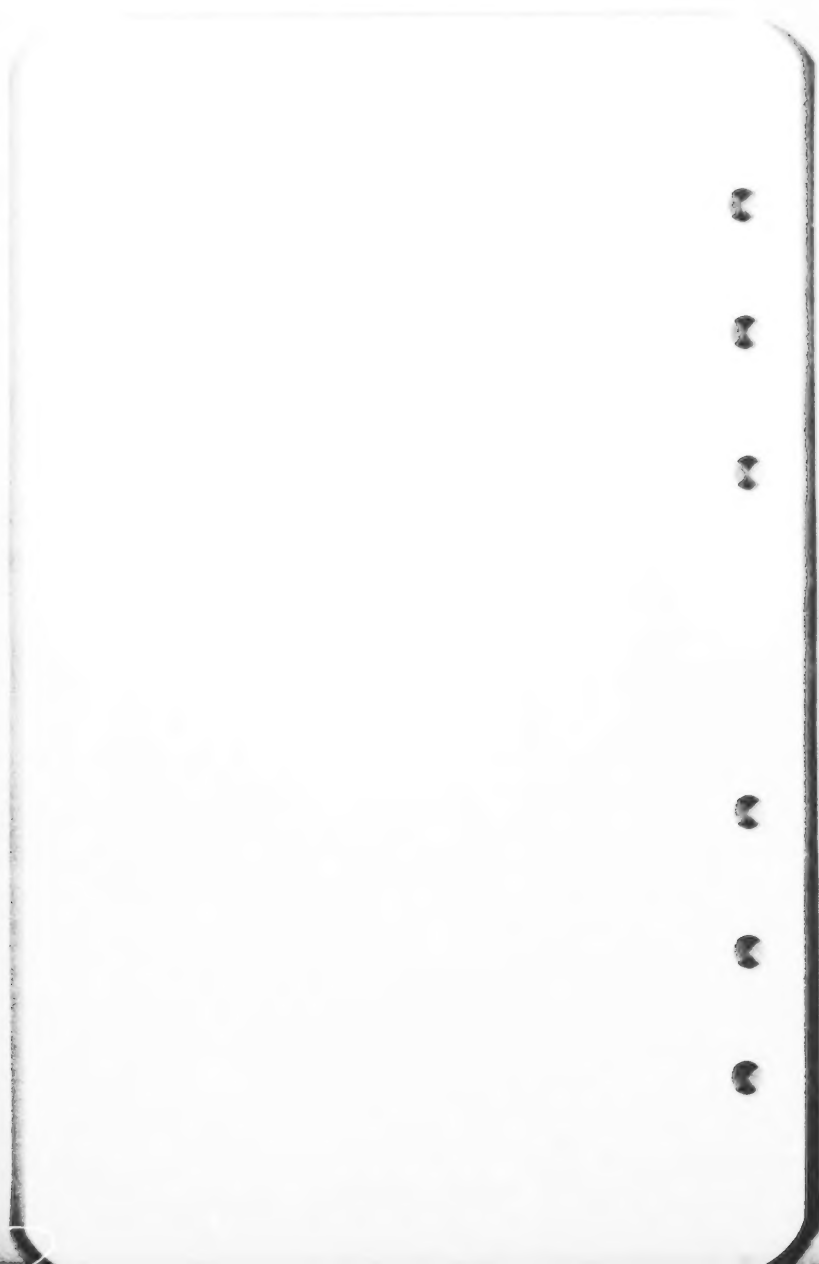
Species	CHEMICAL				
	2,4-D	Roundup	Valpar	Simazine	Asulam
<i>Acer glabrum</i> (Douglas maple)	2	4?	—	—	—
<i>Acer macrophyllum</i> (bigleaf maple)	1-2	3-4	—	—	—
<i>Alnus incana</i> ssp. <i>terrestris</i> (mountain alder)	4	4	1-2	—	—
<i>Alnus rubra</i> (red alder)	5	4	—	—	—
<i>Alnus viridis</i> (Silka or green alder)	4	4	1-2	—	—
<i>Athyrium filix-femina</i> (lady fern)	—	4-5	—	—	—
<i>Betula papyrifera</i> (paper birch)	4	4	3	—	—
<i>Calamagrostis canadensis</i> (bluejoint)	—	4	4-5	4?	—
<i>Calamagrostis rubescens</i> (pinegrass)	—	—	4	4	—
<i>Cornus sericea</i> (red-osier dogwood)	1-2	1-2	2	—	—
<i>Corylus cornuta</i> (hickory)	2	3	—	—	—
<i>Epilobium angustifolium</i> (flewweed)	—	(2)-4	3	2	—
<i>Gaultheria shallon</i> (salal)	1	1	—	—	—
<i>Lonicera involucrata</i> (black twinberry)	—	5?	4?	—	—
<i>Menziesia ferruginea</i> (false azalea)	—	4?	—	—	—
<i>Polystichum munitum</i> (sword fern)	1-2	3-5	2	—	1-2
<i>Populus balsamifera</i> ssp. <i>balsamifera</i> (balsam poplar)	1-2	4	4-5	—	—
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> (black cottonwood)	1-2	4	4?	—	—
<i>Populus tremuloides</i> (trembling aspen)	3-4	4	4	—	—
<i>Pteridium aquilinum</i> (bracken)	1-2	4-5	—	—	4-5
<i>Rhododendron abaltorum</i> (white-flowered rhododendron)	—	3	—	—	—
<i>Ribes bracteosum</i> (stink currant)	2	2(4)	—	—	—
<i>Rubus idaeus</i> (red raspberry)	2	(2)3	3(4)	—	—
<i>Rubus parviflorus</i> (thimbleberry)	1-2	3-4	1-2	—	—
<i>Rubus spectabilis</i> (salmonberry)	1-2	5	—	—	—
<i>Salix</i> spp. (willows)	4	3	2-4	—	—

Explanation of symbols: 1 poor to no control
2 moderate control
3 variable control
4 good control
5 excellent control
— no information

Table 5. Effectiveness of registered herbicides—Continued.

Species	CHEMICAL				
	2,4-D	Roundup	Valpar	Simazine	Asulam
<i>Sambucus racemosa</i> (red elderberry)	1-3	(2)4	—	—	—
<i>Symphoricarpos albus</i> (snowberry)	4	4	—	—	—
<i>Vaccinium membranaceum</i> (black huckleberry)	2	2	?	1-2	—
<i>Vaccinium ovatilobum</i> (oval-leaved blueberry)	2	—	—	—	—
<i>Viburnum adula</i> (highbush-cranberry)	—	4?	2	—	—

Explanation of symbols: 1 poor to no control
 2 moderate control
 3 variable control
 4 good control
 5 excellent control
 — no information



5 GLOSSARY

Allelopathy — The interference of one plant with the growth and development of another through chemicals produced by the plant and released into the environment.

Alluvial — Pertaining to materials or processes associated with transportation or deposition by flowing water.

Autecology — The study of the adaptations and behaviour of individual species, populations or organisms in relation to their environment.

Berry — A fleshy fruit with more than one seed imbedded in pulpy tissue.

Biennial — Completing its life cycle in 2 years. Flowers and fruits are normally produced in the 2nd year of a biennial life cycle.

Cane — A slender, normally short-lived, woody stem that usually arises directly from the ground.

Capsule — A dry, many-seeded fruit that splits open into several sections at maturity (i.e. dehiscent).

Clone — A group of plants propagated only by vegetative or asexual means. All members have been derived from a single individual and thus share the same genetic makeup.

Dehiscent — Splitting open along definite lines at maturity.

Ericaceous — Belonging to the Heather family (*Ericaceae*). Members of this family in British Columbia are typically acid-loving, fairly slow-growing, more-or-less woody plants with simple leaves and perfect (bisexual) flowers. This family includes such genera as *Vaccinium* (huckleberries, blueberries, and cranberries), *Rhododendron*, and *Menziesia* (false azalea).

Girdle — To cut away a ring of inner bark (cambium) completely encircling the stem of a plant so as to interrupt the translocation of carbohydrates through the plant.

Layering — A form of asexual (vegetative) reproduction in which a stem or branch still attached to the parent plant takes root, and eventually becomes a separate plant. Natural layering usually occurs when a branch comes into contact with moist soil or is buried in moist litter.

Nutlet — A small, hard indehiscent (non-opening) fruit containing a single seed.

Perennial — Continuing to grow year after year.

Rhizome — Any prostrate or underground stem, usually rooting at the nodes. Rhizomes may look very much like roots, but they are formed of stem tissue and thus possess a central pith.

Riparian — Situated along the bank of a river or other body of water.

Seed banker — A plant species whose reproductive strategy involves the production of long-lived seed that is stored in the

forest floor until stimulated to germinate by a change in environmental conditions such as fire, increased light, or soil disturbance.

Seedling banker — A plant species whose reproductive strategy involves the production of shade-tolerant seedlings that persist in an extremely slow-growing state beneath an overstory canopy until overstory removal or other environmental change creates conditions favourable to growth and maturation of the seedling.

Sprout — An aerial shoot arising adventitiously or from dormant buds along the stem or at the base of the plant. Basal sprouts are those sprouts that arise at the base of a stem or from the root crown following damage to the parent plant. Stump sprouts are produced anywhere on a cut stump, usually from dormant buds or callus (wound) tissue.

Stolon — A trailing or reclining above-ground stem which forms roots and sends up new shoots where it touches the soil.

Sucker — A branch or shoot from a rhizome or root that ascends above ground. A sucker is distinguished from a sprout in that it is normally produced at some distance from the base of the parent plant, and tends eventually to become a separate plant.